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OF THE

UNITED STATES

GEOLOGICAL SURVEY

No. 170

SURVEY OF THE BOUNDARY LINE BETWEEN IDAHO AND MONTANA FROM THE INTERNATIONAL BOUNDARY TO THE CREST OF THE BITTERROOT MOUNTAINS.—GOODE

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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

SURVEY

OF THE

BOUNDARY LINE BETWEEN IDAHO AND MONTANA

FROM

THE INTERNATIONAL BOUNDARY TO THE CREST OF THE BITTERROOT MOUNTAINS

BY

RICHARD URQUHART GOODE

WASHINGTON

GOVERNMENT PRINTING OFFICE

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LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., February 21, 1900.

SIR: I have the honor to transmit herewith a detailed report relating to the survey of the boundary line between Idaho and Montana from the international boundary to the crest of the Bitterroot Mountains.

I wish to make acknowledgment of the valuable services rendered in this connection by Messrs. S. S. Gannett and D. L. Reaburn, in field and office, and by Mr. E. T. Perkins, jr., in the field. Mr. Gannett prepared the greater portion of the material relating to latitude, longitude, base line, azimuth, and triangulation.

Very respectfully,

RICHARD U. GOODE,
Geographer.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

SURVEY OF THE BOUNDARY LINE BETWEEN IDAHO AND MONTANA FROM THE INTERNATIONAL BOUNDARY TO THE CREST OF THE BITTERROOT MOUNTAINS.

By RICHARD U. GOODE.

INSTRUCTIONS.

The survey of the boundary line between Idaho and Montana was provided for by the Fifty-fourth Congress in the sundry civil act approved June 4, 1897.

The following correspondence is self-explanatory:

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., June 5, 1897.

The honorable the SECRETARY OF THE INTERIOR.

SIR: In response to your verbal request, I have the honor to transmit herewith suggested instructions relating to the survey of the boundary line between Idaho and Montana.

I am, with respect, your obedient servant,

CHAS. D. WALCOTT, *Director.*

INSTRUCTIONS RELATING TO THE SURVEY OF THE BOUNDARY LINE BETWEEN IDAHO AND MONTANA.

Included in the act making appropriations for sundry civil expenses of the Government for the fiscal year ending June 30, 1898, and for other purposes, is found the following law:

For surveying that portion of the boundary line between Idaho and Montana beginning at the intersection of the thirty-ninth meridian with a boundary line between the United States and the British possessions, including the retracing of so much of the international boundary line as may be found necessary for the determination of said intersection, then following said meridian south until it reaches the summit of the Bitterroot Mountains, and for locating points on said meridian by triangulation from the Spokane base of the United States Geological Survey, and on the continuation of said boundary line along the Bitterroot Mountains between Idaho and Montana, seven thousand six hundred and fifty dollars, or so much thereof as may be necessary, to be immediately available: *Provided*, That the Secretary of the Interior shall direct that the survey shall be executed under the supervision of the Director of the Geological Survey by such persons as may be employed by or under him for that purpose, and such survey shall be executed under instructions to be issued by the Secretary of the Interior: *Provided further*, That the plats and field notes thereof prepared shall be approved and

certified to by the Director of the Geological Survey, and three copies thereof shall be returned, one for filing in the surveyor-general's office of Idaho, one in the surveyor-general's office of Montana, and the original in the General Land Office.

In carrying out the provisions of the law above quoted three special processes are involved:

First. The accurate location of the thirty-ninth meridian on the ground by triangulation from the Spokane base of the United States Geological Survey, including the retracing of so much of the international boundary line as may be found necessary for the determination of the intersection of the thirty-ninth meridian with the said boundary line, as well as for locating points on the continuation of the boundary between Montana and Idaho along the summit of the Bitterroot Mountains.

Second. The marking on the surface of the ground, by proper monuments, of the boundary as determined.

Third. The preparation of the necessary plats and field notes.

With reference to the above, the following instructions will be observed:

LOCATING THE BOUNDARY.

The Spokane base of the United States Geological Survey is referred to the meridian of Greenwich, and the thirty-ninth meridian above mentioned has for its initial point the meridian of the old Naval Observatory at Washington. By applying the proper correction and referring the thirty-ninth meridian west of Washington to the meridian of Greenwich, the result is that the meridian to be determined as the boundary line between Idaho and Montana is 116° 03′ 02″.30 west of Greenwich.

The triangulation from the Spokane base will be extended eastward so as to accurately locate the intersection of the meridian above mentioned west from Greenwich with the summit of the Bitterroot Mountains. It may be that this identical point can not be located directly by triangulation, but a point as near thereto as may be possible should be so located, and from this the exact point should be determined by careful traverse based on an astronomic or calculated azimuth and distances determined by direct chaining or stadia measurement, whichever may be most practicable.

After the point referred to, namely, the intersection of the meridian 116° 03′ 02″.30 west from Greenwich with the summit of the Bitterroot Mountains, has been determined, the triangulation is to be extended northward, locating as many points as may be practicable as near as may be to the boundary line between Idaho and Montana until the international boundary is reached. From the points so located by triangulation other points exactly on the boundary will be determined by traverse in the manner hitherto mentioned. The international boundary line is supposedly on the forty-ninth parallel of latitude. It will not, however, answer the purpose to rely on the location of this parallel from the Spokane base, but it must be determined with reference to an existing monument or monuments, being carefully retraced until its point of intersection with the meridian is exactly located.

The distance along the international boundary from the nearest monument, or the monument recovered, to the point of intersection will be determined either by triangulation or direct measurement with chain or stadia or a combination of the two methods.

After points as above described have been located on the boundary line between Idaho and Montana from the international boundary to the summit of the Bitterroot Mountains, these points will be joined by true meridian lines, so that a sufficient number of points on the boundary in addition may be determined to fulfill the conditions made necessary under the provisions hereinafter mentioned for mark-

ing the line. Upon the completion of the survey and marking of the portion of the boundary line coincident with the thirty-ninth meridian, the triangulation will be extended in a southeasterly direction so as to locate points on the continuation of the said boundary line along the Bitterroot Mountains.

All triangulation will be executed in accordance with instructions issued by the Director of the United States Geological Survey under date of February 15, 1897.

In running lines between points located on the boundary the following instructions will be observed:

The instrument used must be a first-class transit instrument, reading to minutes or less, with or without solar attachment, but provided with stadia wires, and must be kept constantly in adjustment. In running the line, double back and fore sights with telescope direct and reversed must be taken, in order to guard against errors resulting from imperfect adjustment of the line of collimation. It is absolutely necessary to follow this method whenever meridian lines are run, in order to avoid errors in the course.

When offset lines are necessary, the notes must fully explain the procedure, and a diagram of such offsets must be inserted after the verbal description.

Observations on Polaris for azimuth must be taken on the line every night, weather and other circumstances permitting, and the record of such observations must be given in detail in the notes in the manner as described in the Manual of Surveying Instructions for the Survey of the Public Lands of the United States, issued by the Commissioner of the General Land Office under date of June 30, 1894.

Temporary marks will be established on the preliminary or random lines between located points, and on reaching a closing point the departure therefrom will be noted. The true line will then be established, and permanent marks placed by shifting the positions of the temporary marks with a swing proportionate to the closure error and distances. Distances along the line will be carried by stadia or chaining, so that it will be possible to locate accurately all monuments established, as well as all topographic and cultural features. The distances thus obtained will be checked in closing from one located point to another.

A full description of all monuments, the character of the timber and soil, the distances to the crossing of all bridges, rivers, lakes, outlines of wooded areas, railroads, roads, trails, and other prominent features will be fully recorded in the field notes, and a sketch of the topographic features adjacent to the boundary line will be made, as well as from each triangulation station on or near the line and from any traverse that may be run in connection with the line. Intersections will be made whenever possible on all important objects susceptible of location.

The magnetic declination will be determined in connection with each transit observation on the line.

MARKING THE LINE.

Monolithic monuments will be placed on the boundary at the following places: Near the Northern Pacific Railway, near the Great Northern Railway, and near the north bank of the Kootenai River. These monuments are to be 6 feet long and 10 inches square, minimum dimensions, and are to be placed in a truly vertical position, set 3 feet in the ground and with their faces directed to the cardinal points. They are to be of undressed stone, except for a space sufficient to cut the words "Idaho" and "Montana" on the west and east sides, respectively, which will be dressed smooth, and the letters shall be 2 inches high, of proportionate width and of the style known as Egyptian. The same kind of monuments will be placed on the line at the international boundary and at the summit of the Bitterroot Mountains if it shall be found practicable to transport them in one mass, otherwise they will be prepared in the quarry in every respect similar to those mentioned above and will then be sawed into sections of such size as to be readily

transported on pack mules to their destinations. They will then be firmly and securely cemeted with Portland cement and established in the same manner as the other stone monuments. The monument on the international boundary in addition to having the inscription "Idaho" and "Montana," on the west and east sides, respectively, will have "Canada" inscribed on the north.

Intermediate between the stone monuments above described will be placed at prominent summits, road, trail, or stream crossings, at distances not exceeding a mile apart, and intervisible whenever possible, wrought-iron posts 6 feet in length, 3 feet of which shall be above ground and 3 feet below the surface, with a brass cap similar in general design to the standard iron posts used by the United States Geological Survey. The cap surmounting the post will be inscribed as below, the line cut on the cap being coincident with the boundary line:

IDAHO
BOUNDARY
LINE
MONTANA

Under each post will be placed a stone marked with charcoal or a vial filled with ashes.

It is assumed that generally a soil surface for the insertion of the stone or iron posts can be found sufficiently near the points it is desired to establish the monuments. If, however, the exact point should fall on rock at the international boundary or the summit of the Bitterroot Mountains, a hole will be chiseled in the rock to a depth of about 8 inches and a little larger than the base of the monument. Into this hole the monument will be firmly cemented with the best Portland cement. If the point for the location of one of the iron posts should fall on a rock surface, a copper plug similar to that used by the United States Geological Survey will be cemented in the rock and a truncated conical mound of stone, not less than 2½ feet high and 5 feet broad, will be placed to the north of the point at a distance of 4 feet from it. The copper plug will be stamped as follows: $\frac{\text{MONT.}}{\text{IDA.}}$ and will be properly oriented.

When suitable bearing trees are found within a distance of 100 feet of a stone monument or iron post, they must be marked on the side facing the corner in the manner prescribed in the manual for special corners.

In addition, each iron post will be witnessed, when possible, by mounds of earth or stone, one in Idaho and one in Montana, the material for the mounds to be taken from pits, one north and one south of the post, dug crosswise of the line. The pits will be 3 feet east and west, 2 feet north and south, and 1 foot deep, and their centers, as well as the centers of the mounds, will be 4 feet from the center of the iron post.

PLATS AND FIELD NOTES.

Special attention is called to the provisions of the law relating to plats and field notes.

All plats and field notes shall be approved and certified to by the Director of the Geological Survey, and four copies thereof shall be returned—one for filing in the surveyor-general's office of Idaho, one in the surveyor-general's office of Montana, one in the office of the Geological Survey, and the original in the General Land Office. All field notes must be transcribed on a typewriting machine.

The results of the topographic notes will be embodied in a map which will be drawn on a scale of 1 inch to a mile. Detailed diagrams of the points on the international boundary and at the intersections of the Bitterroot Mountains will be made.

All parties engaged in the prosecution of this survey will be sworn before an officer duly qualified to administer oaths at the beginning and end of the survey. The oath of the chief of party must be taken either before the clerk of the district court or a United States commissioner. (See Manual, page 64.)

DEPARTMENT OF THE INTERIOR,
Washington, June 5, 1897.

The DIRECTOR OF THE GEOLOGICAL SURVEY.

SIR: Your letter of the 5th instant has been received, submitting for my consideration and approval instructions relating to the survey of the boundary line between Idaho and Montana, for which provision was made in the sundry civil appropriation bill, approved June 4.

The instructions in question have been approved by indorsement thereon and are herewith returned.

Very respectfully, C. N. BLISS, *Secretary.*

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
Washington, D. C., June 7, 1897.

Mr. R. U. GOODE, *Geographer.*

SIR: The execution of the necessary work in connection with the survey of the boundary line between Idaho and Montana, as provided for in the sundry civil bill for the fiscal year 1897–98, is placed under your supervision.

This work will be performed in accordance with instructions approved June 5, 1897, by the Secretary of the Interior.

The sum of $7,650 has been appropriated in this connection, and you are authorized, within the limits of the above appropriation, to employ such temporary field assistants as may be necessary for the proper prosecution of the survey, and to make such journeys and to order your assistants to make such journeys as may be necessary in carrying forward the work.

Very respectfully, CHAS. D. WALCOTT, *Director.*

BOUNDARY LINES.

Territorial and State lines in the northwestern portion of the United States have undergone many changes. Originally this area was included partly in Louisiana and partly in Oregon, the dividing line being the crest of the Rocky Mountains.

Oregon Territory was organized August 14, 1848. Its area at that time included the present States of Oregon, Washington, and Idaho, and portions of Wyoming and Montana. The Territory of Nebraska, formed from a portion of the Louisiana Purchase, was organized May 30, 1854. Its original area extended from Minnesota on the east to the continental watershed on the west, and included the existing State of Nebraska and portions of Colorado, Wyoming, Montana, North Dakota, and South Dakota. The Territory of Dakota was formed March 2, 1861, from parts of the State of Minnesota and the Territory of Nebraska, and on March 3, 1863, the Territory of Idaho was formed of portions of Nebraska, Dakota, and Washington, the latter having been organized March 2, 1853, from a portion of the Territory of Oregon. Originally, Idaho contained about 324,875 square miles, but in 1864 it

was reduced 146,080 square miles by the formation of the Territory of Montana, which was taken entirely from Idaho, and in 1868 it was further reduced by the formation of the Territory of Wyoming, almost the whole of which (93,995 square miles) was taken from Idaho. Montana to-day stands as originally organized, while Idaho contains about 84,800 square miles.

The present boundaries of Montana are described as follows:

Beginning at the intersection of the twenty-seventh meridian of longitude with the boundary line between the United States and the British possessions, it follows said meridian south to the forty-fifth parallel of latitude; thence west on this parallel to the thirty-fourth meridian; south on the thirty-fourth meridian to the point where that meridian intersects the continental watershed; thence westward and northwestward, following the line of the continental watershed and the summit of the Bitterroot Range to its intersection with the thirty-ninth meridian; thence north on the thirty-ninth meridian to the boundary line between the United States and British possessions, and east on that boundary line to the point of beginning.

The present boundaries of Idaho are described as follows:

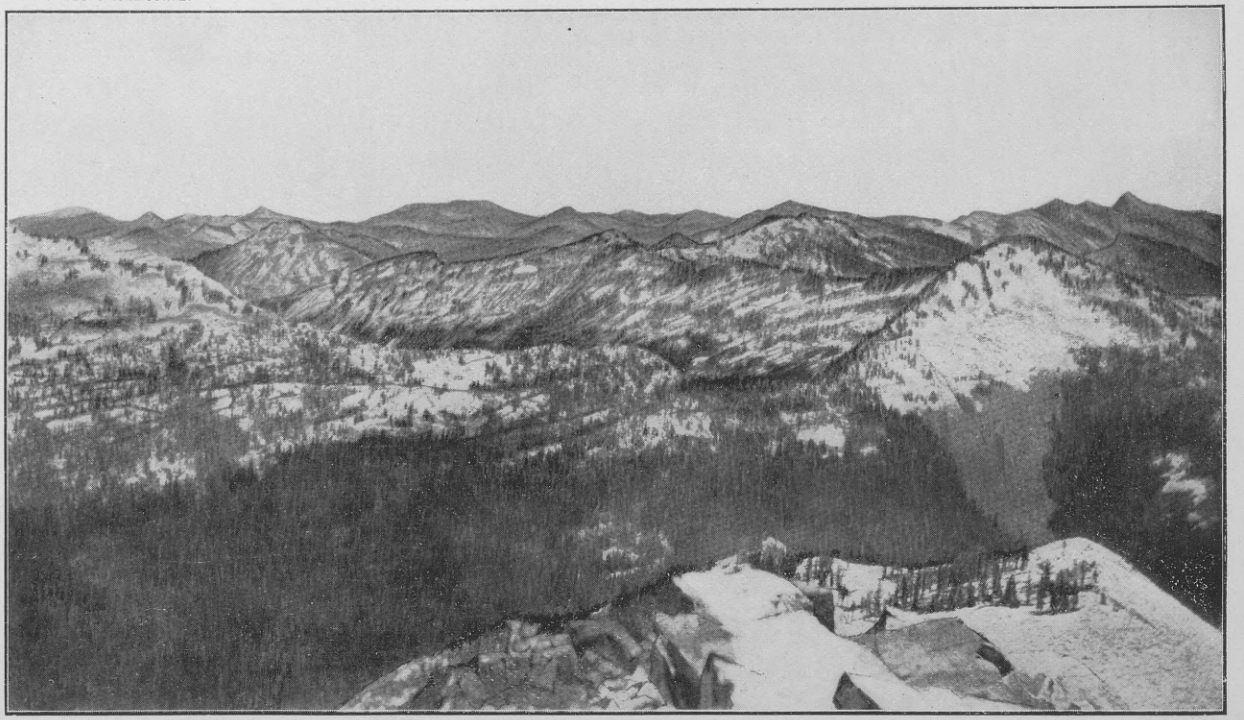
Beginning at the intersection of the thirty-ninth meridian with the boundary line between the United States and the British possessions, it follows said meridian south until it reaches the summit of the Bitterroot Mountains; thence southeastward along the crest of the Bitterroot Range and the Continental Divide until it intersects the meridian of thirty-four degrees of longitude; thence southward on this meridian to the forty-second parallel of latitude; thence west on this parallel of latitude to its intersection with a meridian drawn through the mouth of the Owyhee River; north on this meridian to the mouth of the Owyhee River; thence down the midchannel of the Snake River to the mouth of the Clearwater; and thence north on the meridian which passes through the mouth of the Clearwater to the boundary line between the United States and the British possessions, and east on said boundary line to the place of beginning.

The boundary under discussion is the common one mentioned above.

In the United States State boundary lines may be grouped in two general classes:

First. Those that are defined by some natural physical feature, such as an ocean or a lake shore, the channel or bank of a stream, the summit of a range of mountains, or a watershed.

Second. Those that are defined by imaginary lines which must be traced on the earth's surface by astronomic or mathematical processes. Such a line may be a meridian of longitude, a parallel of latitude, a line between two points (such as a portion of the eastern boundary of Nevada, which is from the intersection of the one hundred and twentieth meridian and the thirty-ninth degree of latitude to a point on the Colorado River where it intersects the thirty-fifth degree of latitude), a line defined by azimuth and distance or a number of such lines consecutively joined (such as the boundary line between Maine and New Hampshire), a line determined by a given direction from a certain point terminating at its intersection with some other line



CREST OF BITTERROOT MOUNTAINS.

(such as a portion of the western boundary of Idaho, which runs from a point in the channel of Snake River opposite the mouth of the Clearwater due north to the thirty-ninth parallel of latitude), or a tangent or arc of a circle (such as the western and northern boundary of Delaware).

Generally speaking, boundary lines of the first class need no monuments to indicate their location, while those of the second class must be perpetuated by marks of some kind after their positions have been determined.

The boundary line between Idaho and Montana is made up of two sections, falling into the two classes mentioned. The first section is that part defined as the thirty-ninth meridian, between the international boundary and the summit of the Bitterroot Mountains; and the second section is the sinuous line corresponding to portions of the crest of the Bitterroot and Rocky mountains, this line beginning at the intersection of one meridian line and terminating at another meridian line. The first section has been located and marked by monuments, as will appear hereafter. The second section is considered to be adequately determined, since it follows a watershed, and its terminal points have been marked—the northern one by the results of the survey under discussion, and the second by the results of the survey of the western boundary of Wyoming, which line follows the thirty-fourth meridian from the forty-first parallel to the crest of the Rocky Mountains. The survey of the latter line was authorized by an act of Congress approved March 3, 1873, and was made, under contract, by Alonzo V. Richards, astronomer and surveyor, in June, July, August, and September, 1874. The following is a description of the corner of Idaho and Montana on this line, as taken from the report of the survey above referred to:

> At 245 miles 56 chains and 50 links the corner of Idaho and Montana was established on the crest of the Rocky Mountains. It is commemorated by a pine post 11 feet long by 15 inches in diameter, 3½ feet in the ground, marked on north face "34° W. L., 1874;" on south face, "246 m. 56 chs. 50 lks.:" on east face, "Wyoming;" on southwest face, "Idaho;" on northwest face, "Montana;" and is squared 2 feet at the upper end in the shape of a pentagon. The point is further perpetuated by a stone in the bottom of the pit in which this post was set, marked "A. V. R," with several charred blocks. A conical mound of earth and stone was raised 4 feet high by 7 feet in diameter, with a pit in the corner of each of the three Territories 3 feet square by 2 feet deep. Then, on the top of the mound, on the east side, was placed a flat sandstone, marked "Wyoming;" another on the southwest side, marked "Idaho," and one on the northwest side, marked "Montana." Nineteen pine trees are noted as witnesses to this post.

It will be noted that the law provides for locating points on the continuation of the boundary line along the Bitterroot Mountains between Idaho and Montana. It was not possible to extend the triangulation beyond the southern extremity of the meridional portion of the boundary line, on account of the available funds not being sufficient for

the purpose. In fact, the appropriation made would not have been adequate for the work that was accomplished if it had not been possible to utilize, in connection with the boundary line, work done under other appropriations. In this manner about 50 miles of the boundary were accurately located in connection with the survey of the Hamilton quadrangle, a portion of which is embraced within the limits of the Bitterroot Forest Reserve.

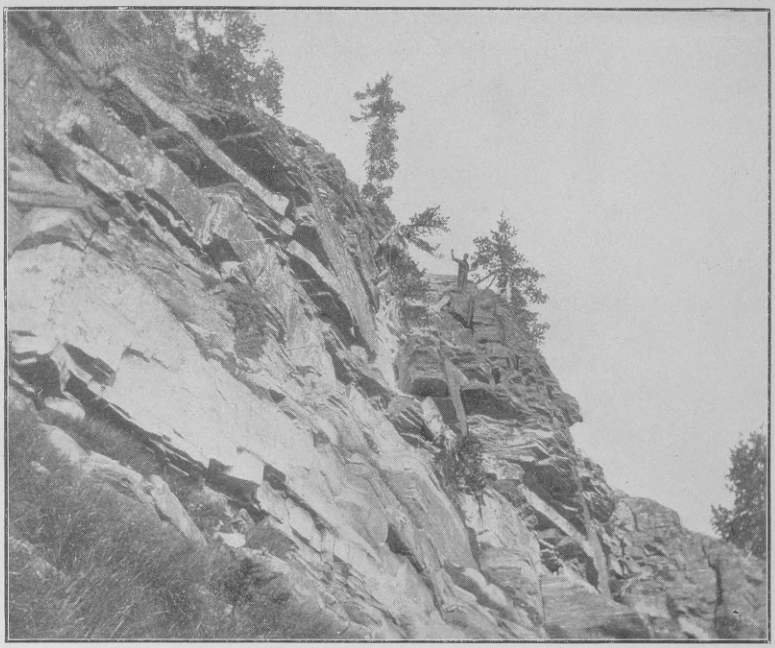
The crest line of the Rocky and Bitterroot mountains between Idaho and Montana is generally a clearly defined summit or watershed, so that no serious question need arise as to its identification as an inter-State boundary. (See Pl. I.) In a few localities, notably in some of the passes, there are morasses of small extent out of which the water flows or seeps in both directions. If the question of placing monuments to mark this line ever arose, the location of monuments in such swampy localities as are found to exist would probably fulfill all necessary requirements. It is, however, very desirable that topographic maps of the adjacent territory be prepared. Such maps would clearly differentiate the true summits from the diverging spurs, and prevent any possible misconception as to the location of the line. After these maps had been prepared there would be no further question of surveying, but merely one of placing monuments, should this be considered necessary.

It frequently happens, as the result of greater or less relative erosion or uplifting, that spurs have an elevation higher than that of the main watershed, and this is remarkably the case in certain portions of the Bitterroot Mountains. In fact, in those portions where detailed examinations have been made all of the higher points of the range are uniformly from 6 to 8 miles east of the present divide, and it is probably true that this divide, in the course of geologic time, has retreated from an irregular line which passed through these high points. This, if true, is due partly to the fact that the waters of the Bitterroot River draining to the eastward have a greater relative rate of fall, and consequently greater erosive power, than had the waters flowing westward through the Clearwater, and thus the territory tributary to the former is gradually being captured by and added to that of the latter.

ACCOUNT OF OPERATIONS.

The work in connection with the boundary line extended through portions of three field and office seasons.

The act providing for the survey of the boundary line was approved June 4, 1897, and Mr. E. T. Perkins, jr., topographer, was immediately detailed for field work in connection with the triangulation. Mr. Perkins left the city of Washington on June 10, and proceeded to Spokane, Washington, by way of Boise, Idaho, stopping at the latter place to arrange for the transportation of certain property to



A CABINET RANGE.

B. SUMMIT OF CABINET RANGE, SHOWING POINTS TOUCHED BY BOUNDARY LINE (A AND B).

be used in connection with the work. The party was organized at Spokane, and at first consisted of only a packer and a cook, but was afterwards increased by the addition of a field assistant, when angle observations were begun. When occasion required, for instance in clearing the timber for a triangulation station, extra men were hired by the day. Transportation was at first by saddle and pack animals alone, but later a light spring wagon was added to the outfit.

The work was greatly retarded by smoke during the summer, which was at times so dense as to render observations impossible, and by unusually early storms in the fall. All operations were entirely suspended about October 1, the snow being so deep as to render practically impossible the ascent of the peaks used as triangulation stations. The season's work consisted in extending the triangulation from the Spokane base eastward, through a longitudinal interval of about 70 miles, to the boundary line. Fifteen stations were erected, nine of which were occupied, and one observation for azimuth was made. Another object accomplished during the field season was the identification on the ground of the Mooyie Trail monument, which had been established by the Northwestern Boundary Commission. This monument was about 8½ miles west of the boundary line between Idaho and Montana, and was the nearest monument or mark of any kind on or near the international boundary that could be identified. Further reference will be made to the Mooyie Trail monument.

After the party was disbanded, Mr. Perkins proceeded to California for duty. During the winter the office work pertaining to the triangulation was done under the direction of Mr. S. S. Gannett. Three figures were adjusted by least squares, and the geodetic positions of nine points were computed. One of the stations, Divide, was found to be 6,072 feet east of the Idaho-Montana boundary line, and another station, Scotchman, was found to be 7,842 feet west of it.

Field operations were resumed in June, 1898, two parties being organized, one for the extension and completion of the necessary triangulation, the other for running the random line northward from the point determined as the intersection of the thirty-ninth meridian west from Washington with the crest of the Bitterroot Mountains.

Mr. Perkins continued the triangulation, and the line party was organized by Mr. S. S. Gannett, topographer, with Mr. D. L. Reaburn, as transit man, the latter assuming charge of the party after the work was started.

Mr. Perkins extended his work of the preceding year northward to the international boundary, occupying nine new stations and reoccupying four old ones. A high signal was erected over the Mooyie Trail monument, and this point was located. Unfortunately the character of the country was such that it was impossible to get a location by triangulation near the northern terminus of the interstate boundary line.

Mr. Gannett was instructed to carefully examine the topographic features of the country adjacent to the triangulation station Divide, in order to determine whether it was on the true summit of the Bitterroot Mountains, and then, by traverse from the Divide station, to locate the exact point on the summit from which, as the initial point, the random line should be projected northward. Observations for azimuth were obtained at Divide, the details of which will appear hereafter, and also at the end of the traverse line. This traverse was run along the divide westward through a longitudinal interval which was supposed to be 6,072 feet, but, unfortunately, owing to an error in the field computations, the location of the initial point was made 177 feet too far east. This error was discovered in the office, and in the adjustment of the random line it was entirely eliminated from the final results.

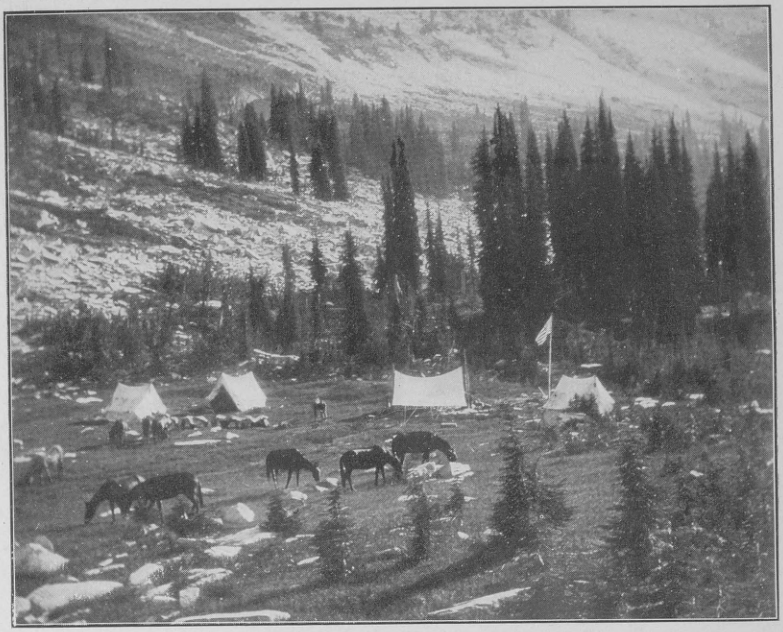
Work on the random line was commenced July 11 by the party under Mr. Reaburn, which consisted of one recorder, two rodmen, two packers, three axmen, and a cook. The region traversed was along the entire line very rough and generally covered with timber. There were few roads or open trails, and the transportation problem was a difficult one. A pack train was provided, and it was generally necessary to make long detours and to cut out trails in order to establish camps at convenient points near the line. Toward the close of the season a great deal of snow was encountered on the high ridges, the party narrowly escaping being snowed in without provisions. The survey of the random line was completed to the vicinity of the international boundary on October 31 in snow $2\frac{1}{2}$ feet deep.

Horizontal and vertical distances along the entire line were obtained by stadia measurements. The total rise and fall of the boundary line was about 63,000 feet, the average length of sights 350 feet, length of line about 72 miles, number of transit stations 1,051, and number of azimuth stations 17.

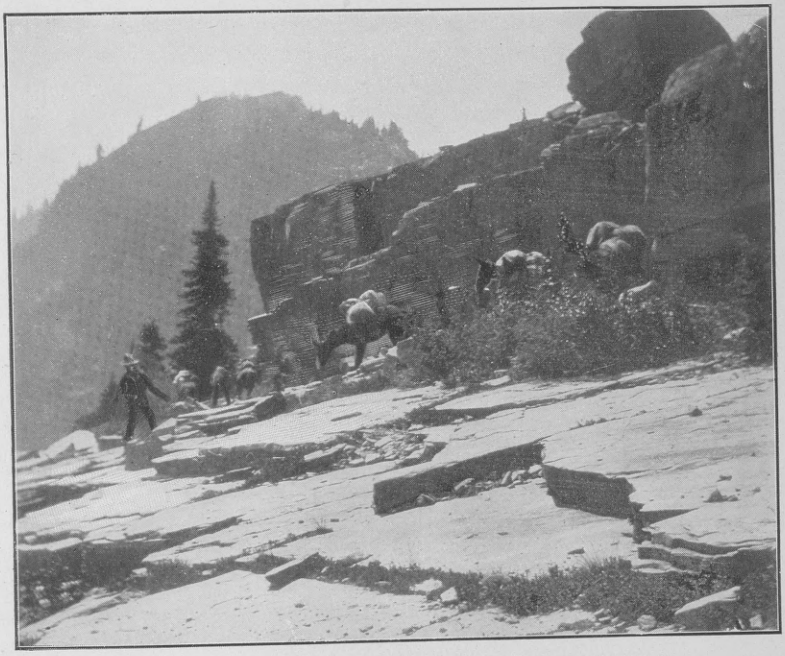
At the conclusion of the field season Mr. Perkins returned to the office and Mr. Reaburn was ordered to field duties elsewhere.

During the office season of 1898–99, after the triangulation had been finally computed, an adjustment of the stadia work to the triangulation was made, and tables were prepared showing the exact latitudinal and longitudinal corrections to be applied at each station of the random line. Elevations were also computed from the vertical angles for each transit station. Six sheets on mounted drawing paper, each sheet extending through a latitudinal interval of 10′, were then prepared. On these sheets was drawn the boundary line in its true position, and all topographic features which had been located from the random line were indicated. Such elevations as would be useful in sketching contours were also placed on the sheets, and the sheets thus arranged were used for sketching the topography adjacent to the line.

Mr. Reaburn resumed field operations about the middle of June,



A. CAMP SOUTH OF SUMMIT OF CABINET RANGE.



B. QUARTZITE SLATE NEAR SUMMIT OF SCOTCHMAN PEAK.

1899, the party as organized being similar to that of the preceding season. The field work which remained was to remeasure a portion of the line, place the monuments, cut out the true line, and secure additional data for the map.

The line was divided into four sections, reference to which will be made hereafter. Three of them were controlled by triangulation, but the fourth, or northernmost section, not being so controlled, it was decided to remeasure that section with the stadia, and also to make a careful comparative measurement with a steel tape. The measurement with the steel tape served not only to check this section of the line, but was also used as a basis of comparison with the stadia measurements and to determine a stadia factor, which was afterwards applied to all of the stadia work.

The measurements of the northernmost section were first made, and the northern terminal point of the line determined. The party then started southward, and the monuments were established, marked, and witnessed in accordance with the instructions. The topography was also sketched, but as the territory through which the line ran was for the most part covered with timber, it was impossible, without delaying the work beyond the limit of the available funds, to cover more than a narrow belt. This work was completed October 5, 1899, and after a short service in another locality Mr. Reaburn reported to the office in Washington for the preparation of the final notes and plats.

LATITUDE, LONGITUDE, BASE LINE, AZIMUTH, AND TRIANGULATION.

In the following pages is given a short account of the methods employed in establishing what may be termed "the control" for the boundary line.

By combining the results of the latitude, longitude, and azimuth observations with the base-line measurement, the position on the earth's surface and the length and true direction of a line were determined. Through a system of triangulation based on the line thus established the positions of points near the boundary line were computed, as well as the distances and directions between these points.

LATITUDE.

The new county court-house at Spokane having been built very close to the longitude pier of the United States Coast and Geodetic Survey of 1888, the latter could not be used as a latitude pier. A new pier was therefore built 67.4 feet east of the longitude pier, where an unobstructed view of the meridian could be obtained. (See Pl. IV.)

A Fauth combined transit and zenith telescope (No. 534) was mounted on this pier, and in August, 1896, observations for latitude, by the Talcott method, were made by Mr. S. S. Gannett. Pairs

of stars were selected from Safford's Catalogue of 2018 Stars. The apparent day places, however, were obtained from the Berliner Jahrbuch whenever possible; otherwise, they were computed by the usual methods, as explained in the American Ephemeris.

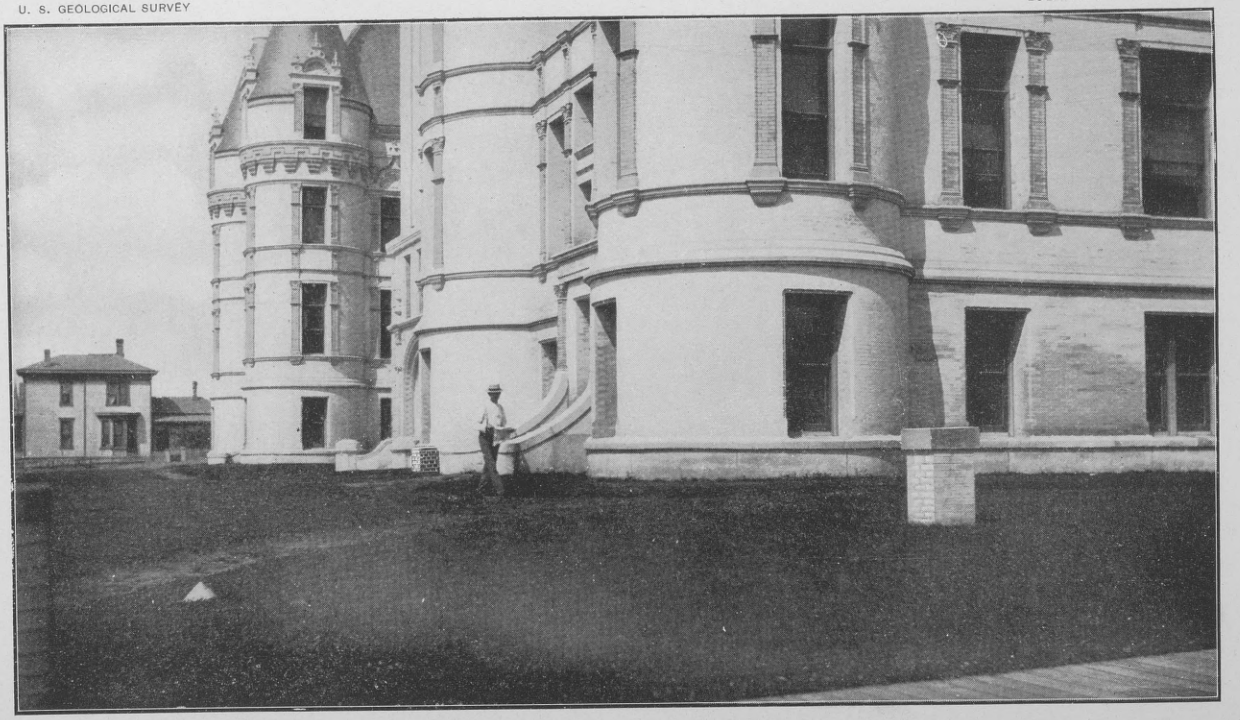
Fifty-nine observations upon twenty-seven pairs of stars gave a weighted mean value for the latitude of the pier of 47° 39′ 51″.46 ± 0″.13. The results for different nights and for different pairs of stars are given in the following table:

Results for latitude, Spokane (Washington) Station, 1896.

[S. S. Gannett, observer and computer.]

Stars (Safford), number and class.	Individual results. 47° 39′.				Mean.	Weight.
	Aug. 6.	Aug. 7.	Aug. 8.	Aug. 9.		
	Seconds.	*Seconds.*	*Seconds.*	*Seconds.*	*Seconds.*	
748 A, 759 A	.....	.....	51.54	50.17	50.85	1.72
766 A, 782 C	.....	50.05	.....	53.27	51.66	1.28
772 A, 782 C	.....	.....	.....	51.46	51.46	0.79
795 C, 801 AA	.....	51.69	50.70	50.66	51.02	1.69
809 C, 852 A	.....	50.04	50.92	49.01	49.99	1.62
814 A, 852 A	.....	50.16	49.68	49.80	49.88	2.40
814 A, 856 AA	.....	50.90	49.57	.....	50.24	1.80
809 C, 856 AA	.....	50.78	50.80	.....	50.79	1.32
809 C, 834 AA	.....	.....	.....	49.81	49.81	0.80
814 A, 834 AA	.....	.....	.....	50.58	50.58	0.96
882 AA, 917 C	.....	.....	52.08	.....	52.08	0.80
901 C, 903 AA	.....	.....	.....	51.05	51.05	0.80
903 AA, 920 C	.....	.....	.....	50.65	50.65	0.80
931 B, 949 A	.....	52.56	.....	49.71	51.13	1.63
957 A, 969 A	.....	52.15	.....	51.30	51.67	1.72
987 A, 989 B	53.81	53.58	53.12	52.52	53.26	2.70
989 B, 1000 AA	52.46	52.90	52.38	51.74	52.37	2.90
1011 B, 1032 B	.....	.....	.....	51.57	51.57	0.88
1016 B, 1032 B	52.10	.....	51.57	52.66	52.11	2.05
1032 B, 1037 B	51.62	51.36	51.78	51.20	51.49	2.47
1032 B, 1047 C	.....	51.58	52.02	50.15	51.25	1.53
1059 A, 1078 A	52.82	51.59	51.75	49.14	51.32	2.99
1188 AA, 1129 A	.....	52.21	51.37	51.07	51.16	2.55
1129 A, 1146 B	.....	53.54	53.37	.....	53.45	1.63
1133 AA, 1158 A	.....	.....	.....	52.63	52.63	0.96
1161 A, 1173 C	.....	.....	50.30	.....	50.30	0.79
1202 AA, 1207 A	.....	53.06	53.00	.....	53.03	1.80

Weighted mean, 47° 39′ 51″.46 ± 0″.13.



ASTRONOMIC PIERS IN COURT-HOUSE GROUNDS AT SPOKANE, WASHINGTON.

U. S. Geological Survey latitude pier in right foreground; U. S. Coast and Geodetic Survey longitude pier behind figure of man.

LONGITUDE.

The meridional portion of the line is defined as corresponding to the thirty-ninth degree of longitude west from Washington.

Section 435, Revised Statutes, provides that "The meridian of the Observatory at Washington shall be adopted and used as the American meridian for all astronomical purposes," and this has been construed as meaning the old Naval Observatory. The latest adjustment by the United States Coast and Geodetic Survey fixes the longitude of the center of the dome of the United States Naval Observatory (old site) at $5^h\ 08^m\ 12^s.153 \pm 0^s.049$, or $77°\ 03'\ 02''.30 \pm 0''.74$; hence the longitude of the meridian corresponding to the boundary line between Idaho and Montana is $116°\ 03'\ 02''.30$.

The United States Coast and Geodetic Survey has published an adjusted network of telegraphic longitude determinations, including points distributed in various localities throughout the United States. This system includes the Naval Observatory at Washington and also a station at Helena, Montana. From Helena the Coast Survey in 1888 determined the longitude of a pier in the court-house grounds at Spokane.

The nightly programme at each station was to observe, with an astronomic transit, two sets of ten stars each for local time, each half set consisting of four stars having a mean azimuth factor nearly equal to zero, and one circumpolar star. Two such half sets, with a reversal of the telescope in the Y's between them, give a strong time determination. The same sets of stars were observed at Helena and at Spokane, thus giving the chronometer error for each local meridian.

Between the two time sets the chronometers were compared by telegraph, thus giving the difference in time, and consequently in longitude, between the meridians within a small fraction of a second. As will be noticed in the following table, such observations and chronometer comparisons were made on four nights, when the observers interchanged places and made similar observations and chronometer comparison on four other nights, thus eliminating the effect of "personal equation."

The figures relating to this description, which were kindly furnished by the Superintendent of the United States Coast and Geodetic Survey, are presented below:

Resulting difference of longitude between the astronomic stations at Spokane, Washington, and Helena, Montana, as determined by the United States Coast and Geodetic Survey in September, 1888.

Date.	Observer.		From western or Spokane signals.	From eastern or Helena signals.	W. E.	Mean of west and east signals.	Correction for personal equation.	Difference of longitude. $\Delta\lambda$	Combination weight.	Difference. v
	Spokane.	Helena.								
1888.			′ ″	′ ″	°	′ ″	″	′ ″		″
Sept. 13	R. A. Marr.	C. H. Sinclair.	21 34.193	21 34.171	0.022	21 34.182	+0.208	21 34.390	6	+0.047
Sept. 15			.218	.164	.054	.191	.....	.399	5	+ .038
Sept. 22			.299	.247	.052	.273	.....	.481	5	— .044
Sept. 24			.283	.224	.059	.254	.....	.462	10	— .025
				Mean...	.047	21 34.225				
Sept. 26	C. H. Sinclair.	R. A. Marr.	21 34.616	21 34.591	0.025	21 34.604	—0.208	.396	4	+ .041
Sept. 27			.702	.673	.029	.687	.....	.479	4	— .042
Sept. 28			.667	.625	.042	.646	.....	.438	5	— .001
Sept. 29			.663	.619	.044	.641	.....	.433	5	+ .004
				Mean...	.035	21 34.644	.....	21 34.435		
					Weighted mean.....			21 34.437		± 009

Transmission time, $0^s.020 \pm 0^s.002$.

Personal equation, Marr-Sinclair, $0^s.208 \pm 0^s.009$.

At Spokane, transit No. 19 was mounted in the grounds of the county court-house.

At Helena, transit No. 18 was mounted over the station in the northwest corner of the grounds of the United States assay office. The station was established in 1888. The court-house tower is $0^s.324$ or $4''.86$ east and $0''.811$ south of the transit.

$\Delta\lambda$ Spokane-Helena $= 21^m\ 34^s.437 \pm 0^s.009$.

λ Helena (transit 1888), $7^h\ 28^m\ 08^s.789 \pm 0^s.052$.

λ Spokane (transit), $7^h\ 49^m\ 43^s.226 \pm 0^s.053$.

$117°\ 25'\ 48''.39 \pm 0''.80$.

From the foregoing it will be observed that the probable error of the longitude determination of the Spokane pier is $0''.80$, or about 54 feet. Through a connection with the pier at Spokane the longitude of the meridian of the boundary line was established by triangulation and traverse, as will appear hereafter.

It may be remarked, in connection with the foregoing, that while the meridian of the Observatory at Washington is, by law approved September 28, 1850, the American meridian for all astronomical purposes, the geodetic operations of the country generally are conducted with reference to the meridian of Greenwich as an initial point. Government maps are usually referred to Greenwich, and standard time is reckoned from it.

SPOKANE BASE LINE.

A site for this base line was found in the valley of the Spokane River, east of the city of Spokane, points for its expansion being located on the surrounding hills. The line was measured along a tangent of the Northern Pacific Railway, beginning about 2.5 miles east of the Spokane depot and extending eastward 5 miles. It was prepared by nailing boards 1 by 6 by 60 inches 300 feet apart along the cross-ties parallel to the rail. On each board a smaller board (1 by 4 by 12 inches) was nailed, and on the latter was tacked a strip of zinc 2 by 10 inches. At night two complete measurements were made with United States Geological Survey steel tape No. 1, under a tension of 20 pounds, temperature being taken by reading three thermometers at each tape length. The front end of the tape was marked on the zinc strip with a fine brad awl. The length of the tape used, compared with the mural standard of the United States Coast and Geodetic Survey on October 30, 1895, was found to be 300.0075 feet; on December 5, 1896, 300.0058 feet. The mean of these two, 300.0067 feet, was adopted.

Adopted coefficient of expansion	F	.0000065
Mean temperature of first measurement		60°.35
Mean temperature of second measurement		59°.25
Difference between the two measurements, when corrected for temperature	feet	.006
Mean elevation of the line above sea level, as given by a profile furnished by the Northern Pacific Railway	feet	1,972
Length of base corrected for temperature	do	26,407.288
Correction for inclination	do	—0.156
Reduction to sea level	do	—2.491
Reduced length	do	26,404.641
Logarithm of length, in meters		3.9056962

The terminal points were transferred to the embankment 25 feet north of north rail, and the new points being intervisible, high tripod supports for the theodolite were necessary.

AZIMUTH.

The azimuth of the Spokane base line was determined by mounting 8-inch micrometer theodolite No. 300 over the west base and measuring the angle between Polaris and a mark placed at the east base. A series of observations, consisting of eighteen pointings (direct and reverse), was taken near elongation August 15, 1896, the resulting mean for azimuth west base-east base being 253° 18′ 45″.80.

With this value and the astronomic location of the cupola of the court-house at Spokane the positions of all triangulation stations and azimuths of all lines in the main belt of triangulation eastward

to Divide and Scotchman stations, near the Idaho-Montana boundary line were computed. A check azimuth was observed at Divide triangulation station July 7, 1898, with the same theodolite. Twenty pointings (direct and reversed) on Polaris were obtained and referred to Scotchman station.

	°	′	″
Azimuth of line Divide-Scotchman computed from Spokane base	170	18	05.87
Azimuth of same line by direct observation	170	18	10.25
Difference			4.38

The observed value was adopted in the computation of positions in the extension of the triangulation northward to the international boundary.

Examples of record and computation for azimuth determination are given herewith:

Azimuth determinations at triangulation station Divide, July 7, 1898. S. S. Gannett, observer.

[Latitude (ϕ) 47° 57′ 57″.51. Longitude (λ) 116° 01′ 33″.08]

	Time.	Level. W.	Level. E.	Micrometer A.	Micrometer B.	Mean.	Angle.
	h. m. s.	*d.*	*d.*	° ′ *d.*	° ′ *d.*	° ′ ″	° ′ ″
Azimuth mark		13.0	16.0	221 09 02	41 09 13	221 09 15	
Polaris D	10 27 52	11.8	18.0	255 33 24	75 34 07	255 34 01	34 24 46
		24.8	34.0				
		−9.2					
Polaris R	10 33 48	13.8	15.3	75 36 08	255 34 21	75 35 29	
Azimuth mark		14.0	15.0	41 09 18	221 08 11	41 08 59	34 26 30
		27.8	30.3				
		−2.5					
Azimuth mark		14.0	11.5	78 10 23	258 09 09	78 10 02	
Polaris R	10 42 02	13.5	12.0	112 39 14	292 38 08	112 38 52	34 28 50
		27.5	23.5				
		+4.0					
Polaris R	10 46 08	16.0	16.0	292 40 02	112 40 11	292 40 13	
Azimuth mark		18.2	14.0	258 09 28	78 10 14	258 10 12	34 30 01
		34.2	30.0				
		+4.0					

Time by mean time watch, 34 seconds fast on one hundred and fifth meridian time.

One division of striding level = 3″.66; 1 division of micrometer = 2″.00.

Level correction $= -\frac{d}{4}\left\{(w+w')-(e+e')\right\}\tan h$; d being the value of a division of the level, $w + w'$ readings of west end of level bubble, $e + e'$ readings of east end of level bubble, and h, the angular elevation of star, the foregoing formula reduces as follows:

$$\frac{3''.66}{4} \times \tan 47° 57' 57'' \ (1.11) = 1''.01.$$

The formula for reduction of azimuth observations at any hour angle is $\tan A = -\frac{a \sin t}{1 - b \cos t}$, where $a = \sec \phi \cot \delta$, $b = \tan \phi \cot \delta$.

	°	′	″		
log sec ϕ,	47	57	57 = 0.17421	log tan ϕ =	0.04505
log cot δ,	88	45	46 = 8.33439	log cot δ =	8.33439
log a			= 8.50860	log b =	8.37944

	m.	*s.*	
Watch correction	— 0	34	
Longitude correction	—44	06	
Total correction	—44	40	

	Computation of first observation.	Computation of second observation.	Computation of third observation.	Computation of fourth observation.
	h. *m.* *s.*	*h.* *m.* *s.*	*h.* *m.* *s.*	*h.* *m.* *s.*
Watch time of observation	10 27 52	10 33 48	10 42 02	10 46 08
Reduction to local meridian	—44 40	—44 40	—44 40	—44 40
Local mean time	9 43 12	9 49 08	9 57 22	10 01 28
Correction to sidereal	+1 36	+1 37	+1 38	+1 39
α of sun	7 03 11	7 03 11	7 03 11	7 03 11
Sidereal interval	16 47 59	16 53 56	17 02 11	17 06 18
α of Polaris	—1 21 51	—1 21 51	—1 21 51	—1 21 51
t	15 26 08	15 32 05	15 40 20	15 44 27
	° ′ ″	° ′ ″	° ′ ″	° ′ ″
t in arc	231 32 00	233 01 15	235 05 00	236 06 45
Log cos t	9.79383	9.77925	9.75769	9.74630
Log b	8.37944	8.37944	8.37944	8.37944
Log b cos t	8.17327	8.15869	8.13713	8.12574
b cos t	.01490	.01441	.01371	.01336
$1 - b$ cos t	1.01490	1.01441	1.01371	1.01336
Log sin t	9.89375	9.90246	9.91381	9.91915
Log a	8.50860	8.50860	8.50860	8.50860
Log a sin t	8.40235	8.41106	8.42241	8.42775
Log $(1 - b \cos t)$	0.00642	0.00621	0.00591	0.00575
Log tan A	8.39593	8.40485	8.41650	8.42200
	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Azimuth of star	181 25 32	181 27 18	181 29 41	181 30 49
Angle to mark	—34 24 46	—34 26 30	—34 28 50	—34 30 01
Level correction	+9	+2	—4	—4
Azimuth of mark	147 00 55	147 00 50	147 00 47	147 00 44

The mean of twenty observations reduced in a similar manner = 147° 00′ 51″.15.

Check azimuths along the random line were measured with Young transit No. 6838. The instrument was usually set over one stadia station and a mark placed on another station. Six measurements (three direct and three reversed) of angle between Polaris and mark were then made. These observations were reduced at once by the

method and tables given in the Manual of Surveying Instructions issued by the General Land Office, 1894, pages 109–119. An example of record and computation follows.

[July 19, 1898. Stadia ⊡ 77. D. L. Reaburn, observer.]

TELESCOPE DIRECT.

	Time.	A.	B.	Mean.	Angle.
	h. m. s.	° ′ ″	° ′ ″	° ′ ″	° ′ ″
Azimuth mark		0 03 30	180 03 30	0 03 30	
Polaris	9 03 40	1 19 00	1 18 30	1 18 45	1 15 15

TELESCOPE REVERSED.

Polaris	9 15 18	180 23 00	0 22 30	180 22 45	
Azimuth mark		180 02 30	180 02 30	0 02 30	1 20 15

TELESCOPE REVERSED.

Azimuth mark		35 14 00	215 14 00	35 14 00	
Polaris	9 30 00	36 38 30	216 38 30	36 38 30	1 24 30

TELESCOPE DIRECT.

Polaris	9 33 30	36 40 00	216 40 00	36 40 00	
Azimuth mark		35 14 00	215 14 00	35 14 00	1 26 00

TELESCOPE DIRECT.

Azimuth mark		81 12 00	261 12 00	81 12 00	
Polaris	9 39 45	82 39 00	262 39 00	82 39 00	1 27 00

TELESCOPE REVERSED.

Polaris	9 41 45	82 41 00	262 40 30	262 40 45	
Azimuth mark		81 12 00	261 11 30	81 11 45	1 29 00

[July 19, 1898. Stadia ⊡ 77. Latitude 48° 03′; longitude 116° 03′. Watch fast 42^{m} 36^{s} on local time.]

	H.	M.
Upper culmination Polaris, July 15	17	43.5
Reduction to July 18		−11.8
Upper culmination July 18, being culmination preceding time of observation on July 19	=17	31.7

[D. L. Reaburn, computer.]

	Computation of first observation.	Computation of second observation.	Computation of third observation.	Computation of fourth observation.	Computation of fifth observation.	Computation of sixth observation.
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
Time of observation	9 03.7	9 15.3	9 30.0	9 33.5	9 39.7	9 41.7
Watch correction	—42.6	—42.6	—42.6	—42.6	—42.6	—42.6
Local mean time	8 21.1	8 32.7	8 47.4	8 50.9	8 57.1	8 59.1
	+24	+24	+24	+24	+24	+24
	32 21.1	32 32.7	32 47.4	32 50.9	32 57.1	32 59.1
Subtract up. culmination	—17 31.7	17 31.7	17 31.7	17 31.7	17 31.7	17 31.7
Hour angle	14 49.4	15 01.0	15 15.7	15 19.2	15 25.4	15 27.4
Subtract from	23 56.1	23 56.1	23 56.1	23 56.1	23 56.1	23 56.1
Time argument	9 06.7	8 55.1	8 40.4	8 36.9	8 30.7	8 28.7
Azimuth Polaris—	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″
At observation	181 13 45	181 18 30	181 23 12	181 24 16	181 26 00	181 27 00
Angle to mark	1 15 15	1 20 15	1 24 30	1 26 00	1 27 00	1 29 00
Azimuth of mark	179 58 30	179 58 15	179 58 42	179 58 16	179 59 00	179 58 00

Mean = 179° 58′ 33″ showing this portion of the random line to deviate from the true meridian by 1′ 27″.

TRIANGULATION.

The triangulation connecting the Spokane base with the boundary line was done with an 8-inch micrometer theodolite, reading by two micrometers to two seconds and by estimation to one second. Directions were read in sets, each set consisting of pointings with telescope direct and reversed from left to right and from right to left. Four or more of such sets were usually taken. A few secondary locations on or near the boundary line were made with the transit. All of the observations were reduced in the office by least squares.

The following list gives descriptions, latitude, longitude, azimuths, and distances of the triangulation stations determined which have a bearing on the boundary line.

A diagram of the triangulation is also presented. (See Pl. V.)

SPOKANE, EAST BASE.

Station mark: A dressed stone, 7 by 7 by 36 inches, set 30 inches in ground, 25 feet north of north rail, and 94 feet eastward from sign marked "Trent 1 mile." The stone is marked on top "U. S. + E. Base."

[Latitude, 47° 41′ 01″.94. Longitude, 117° 16′ 00″.81.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Moran	14 37 16.02	194 35 48.17	3.9929426
West base	73 23 19.07	253 18 45.80	3.9056962
Court-house cupola	80 02 46.43	259 55 31.41	4.0956581
Little Baldy	117 19 24.54	297 16 30.04	3.7432302
Skalan	288 10 38.61	108 22 55.95	4.3409600

SPOKANE, WEST BASE.

Station mark: A dressed stone, 7 by 7 by 36 inches, set 30 inches in the ground, 25 feet of north rail and 218 feet eastward from signboard, "U. S. + W. Base." "R. R. X'ng ½ mile." Top of the stone is marked

[Latitude, 47° 39′ 47″.28. Longitude, 117° 22′ 10″.45.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Court-house cupola	91 45 38.07	271 42 56.36	3.6595819
Tomkinson	137 10 30.83	317 06 36.14	3.9881446
Little Baldy	209 54 21.35	29 56 00.21	3.7474231
East base	253 18 45.80	73 23 19.07	3.9056962
Skalan	278 57 36.00	99 14 26.34	4.4609400
Moran	324 00 35.75	144 03 41.01	3.9500715

COURT-HOUSE CUPOLA, SPOKANE.

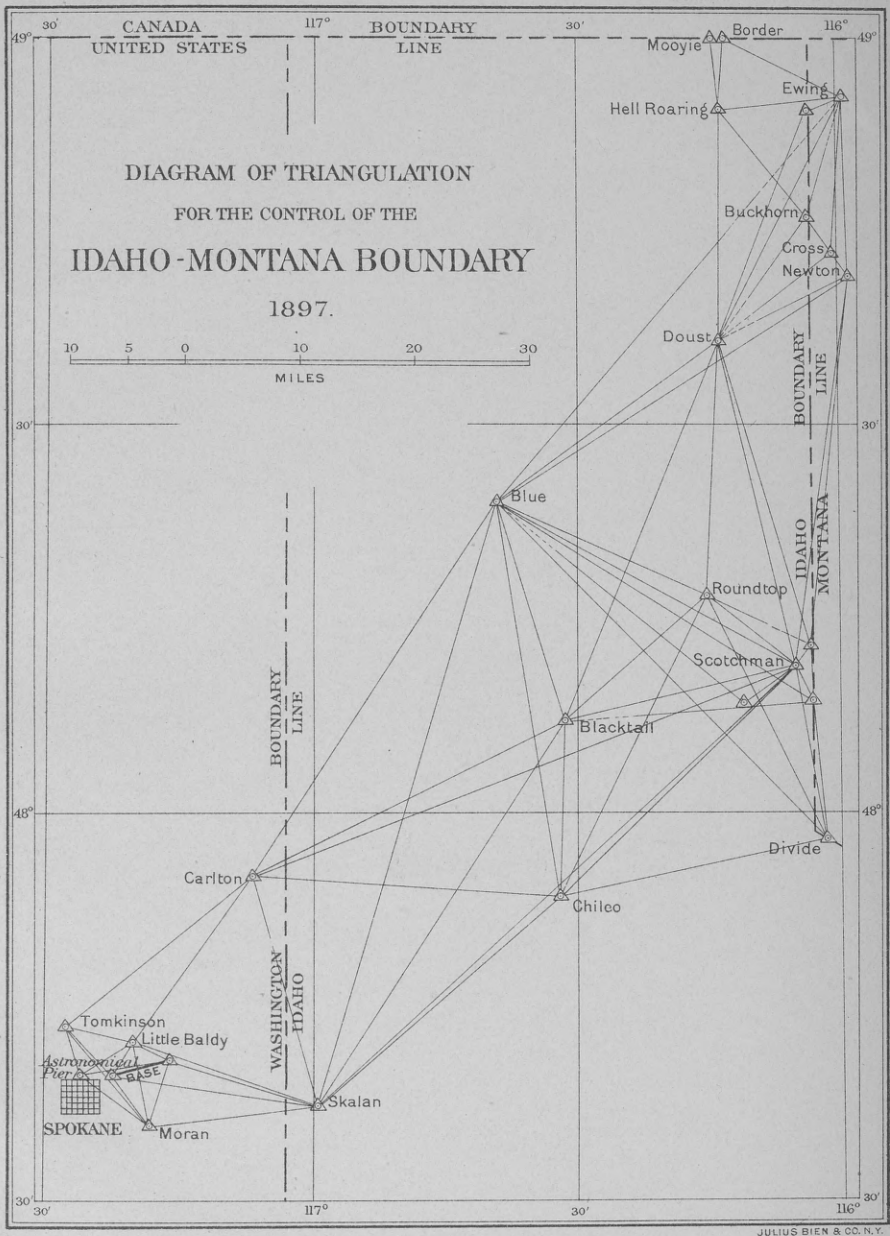
(Not occupied.)

This point is connected, by direct measurement, with longitude pier of the United States Coast and Geodetic Survey of 1888 and with latitude pier of the United States Geological Survey of 1896. It is also connected, by triangulation, with the stations of the base expansion. The point located is the center of the flagstaff, which is over the center of the cupola of the new court-house.

Latitude, 47° 39′ 51″.76. Longitude, 117° 25′ 49″.21.

MORAN, SPOKANE COUNTY.

Location of station: On the northern end of a high, wooded ridge, about 8 miles southeast of Spokane, in a cleared field about 50 feet west of the ruins of a log cabin. A wagon road runs to the station.



JULIUS BIEN & CO. N.Y.

Station mark: A dressed stone, 8 by 8 by 36 inches, set 30 inches in the ground, marked "U. S. ⊙."

[Latitude, 47° 35′ 53″.67. Longitude, 117° 17′ 59″.70.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Court-house cupola	126 55 28.15	306 49 41.22	4.0882682
Tomkinson	140 29 39.00	320 22 39.05	4.2697837
Little Baldy	168 33 40.57	348 32 14.04	4.0900766
Skalan	263 25 05.73	83 38 50.36	4.3704936

LITTLE BALDY, SPOKANE COUNTY.

Location of station: On a small flat-topped hill 5 miles northeast of Spokane, and in the center of a cleared field on the highest part of hill. A fringe of tall pine trees extends around the hill.

Station mark: A dressed stone, 8 by 8 by 36 inches, set 30 inches in the ground, marked "U. S. ⊙."

[Latitude, 47° 42′ 24″.16. Longitude, 117° 19′ 56″.74.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Court-house cupola	57 24 18.29	237 19 57.66	3.9409362
Tomkinson	103 43 22.18	283 37 48.45	3.9857308
Mount Carlton	214 13 32.20	34 23 09.80	4.4590100
Skalan	289 58 08.50	110 13 20.40	4.4378494
East base	297 16 30.04	117 19 24.54	3.7432302

TOMKINSON, SPOKANE COUNTY.

Location of station: On the southern part of a small table-land 4 miles north of Spokane, on the highest knoll in pasture of Mr. Tomkinson and one-eighth of a mile southwest of his house.

Station mark: A dressed stone, 8 by 8 by 36 inches, set 30 inches in the ground, marked "U. S. ⊙."

[Latitude, 47° 43′ 38″.24. Longitude, 117° 27′ 27″.85.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Carlton	229 52 16.64	50 07 28.61	4.5239434
Court-house cupola	343 36 09.45	163 37 22.41	3.8627730

SKALAN, KOOTENAI COUNTY, IDAHO.

Location of station: Twenty miles east of Spokane, Washington, and 3 miles east of Washington-Idaho boundary line. The summit is a bald, rocky ridge, and can be reached by a good trail from Dr. Dennison's ranch, on the east side of Skalan Creek.

Station mark: A copper bolt set in solid rock, above which is a cairn 5 feet in diameter at base and 5 feet in height.

[Latitude, 47° 37′ 19″.26. Longitude, 116° 59′ 23″.15.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Moran	83 38 50.36	263 25 05.73	4.3704936
Little Baldy	110 13 20.40	289 58 08.50	4.4378494
Carlton	164 08 34.00	344 02 57.76	4.5378730
Blacktail	212 17 12.70	32 38 06.17	4.8158528
Chilco	228 45 58.75	49 06 20.29	4.6587750

CARLTON, SPOKANE COUNTY, WASHINGTON.

Location of station: About 35 miles by road and trail northeast of Spokane, Washington. The mountain has two summits of nearly equal height and about one-third of a mile apart. The station is on the southern summit, which is flat and bald, but has a growth of pine and spruce trees on its western side. There is a good trail to station from The Meadows.

Station mark: A copper bolt set in solid rock, above which is a rock cairn 5 feet in diameter and 5 feet in height.

[Latitude, 47° 55′ 13″.71. Longitude, 117° 06′ 57″.26.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Little Baldy	34 23 09.49	214 13 31.91	4.4589864
Tomkinson	50 07 28.61	229 52 16.64	4.5239434
Blacktail	243 24 10.03	63 50 44.00	4.6954456
Chilco	274 01 32.58	94 27 33.97	4.6416575
Skalan	344 02 57.76	164 08 34.00	4.5378730

BLACKTAIL, KOOTENAI COUNTY, IDAHO.

Location of station: On a bald point near the south end of summit, near the western shore of Lake Pend Oreille and east of Cocolalla, on

Northern Pacific Railway. It can be easily reached by trail from T. Trumbull's ranch.

Station mark: A copper bolt sunk in solid rock, above which is a cairn 5 feet in diameter and 5 feet in height.

[Latitude, 48° 07′ 07″.09. Longitude, 116° 31′ 13″.03.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Chilco	1 53 09.56	181 52 39.78	4.4029303
Skalan	32 38 06.17	212 17 12.70	4.8158528
Carlton	63 50 44.00	243 24 10.63	4.6954456
Round Top	228 10 27.76	48 22 33.96	4.4305996
Scotchman	256 22 33.71	76 42 07.01	4.5246835

CHILCO, KOOTENAI COUNTY, IDAHO.

Location of station: On the south end of grassy summit south of the steamboat landing on Lake Pend Oreille. It can be easily reached from Collins's ranch by Leiberg trail.

Station mark: A copper bolt sunk in solid rock, above which is a rock cairn 5 feet in diameter at base and 5 feet in height.

[Latitude, 47° 53′ 28″.75. Longitude, 116° 31′ 53″.09.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Skalan	49 06 20.29	228 45 58.75	4.6587752
Carlton	94 27 33.97	274 01 32.58	4.6416575
Blacktail	181 52 39.78	1 53 09.56	4.4029303
Round Top	205 48 07.02	26 00 41.75	4.6816159
Scotchman	225 10 00.98	45 30 01.97	4.6724527
Divide	257 25 15.62	77 47 46.64	4.5875062

SCOTCHMAN, KOOTENAI COUNTY, IDAHO.

Location of station: On the southwestern of three summits, about a mile west of the Idaho-Montana boundary line and 6 miles northeast of Clark Fork, a station on the Northern Pacific Railway. It can be reached from Lightning Creek by an old Indian trail—a roundabout way, though the easiest one.

Station mark: A copper bolt in solid rock, above which is a rock cairn 5 feet in diameter and 5 feet in height.

[Latitude, 48° 11′ 19″.36. Longitude, 116° 04′ 58″.02.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Chilco	45 30 01.97	225 10 00.98	4.6724527
Blacktail	76 42 07.01	256 22 33.71	4.5246835
Round Top	129 21 22.70	309 13 54.54	4.2047087
Divide	350 15 33.38	170 18 05.87	4.4001417

ROUND TOP, KOOTENAI COUNTY, IDAHO.

Location of station: Northeast of Hope, on the Sherry trail, near Hogeye camp, on the southern end of the summit, which extends 100 yards north and south.

Station mark: A copper bolt sunk in rock, above which is a rock cairn 5 feet in diameter and 5 feet in height.

[Latitude, 48° 16′ 47″.86. Longitude, 116° 14′ 58″.88.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Chilco	26 00 41.75	205 48 07.02	4.6816159
Blacktail	48 22 33.96	228 10 27.76	4.4305996
Scotchman	309 13 54.54	120 21 22.70	4.2047087
Divide	334 24 02.60	154 34 02.58	4.5855553

DIVIDE (1).

Location of station: On a knoll on divide of the Bitterroot Mountains on the boundary line between Idaho and Montana. It is not the highest point, but it is almost cleared of timber. Station is best reached from Heron, Montana, by the Elk Creek trail.

Station mark: A copper bolt sunk in solid rock, above which is a rock cairn 3 feet in height and 3 feet in diameter.

[Latitude, 47° 57′ 57″.51. Longitude, 116° 01′ 33″.08.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Chilco	77 47 46.64	257 25 15.62	4.5875062
Round Top	154 34 02.58	334 24 02.60	4.5855553
Scotchman	170 18 05.87	350 15 33.38	4.4001417

MOOYIE TRAIL MONUMENT.

On or near the boundary line between Kootenai County, Idaho, and British Columbia, about 32 miles northward from Bonners Ferry.

Easily reached by the new Wild Horse trail, 5 miles from Round Meadows or Prairie. Monument is about a half mile beyond a portion of trail filled with loose rocks, and just beyond a heavy growth of timber and underbrush. Where the trail crosses the international boundary there is a large tree squared about 4 feet above the ground. On the south side of the tree are cut the letters "U. S.," on the north side the letters "B. C." Monument is west of this tree.

Station mark: Copper bolt sunk in soil, over which is a monument of loose stone and a tree 20 feet in height.

[Latitude, 49° 00′ 01″.51. Longitude, 116° 14′ 19″.48.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Border	267 48 09.25	87 49 12.16	3.22930
Hell Roaring	353 09 44.78	173 10 30.25	4.01339

BLUE, KOOTENAI COUNTY, IDAHO.

Location of station: On southeasternmost of three summits of nearly equal height, 5½ miles west of Sand Point, on Great Northern Railway, 7 miles west of Sand Point, on Northern Pacific Railway; eight hours' travel from Carr's ranch, on Rider Creek, passing "Old Baldy," thence along ridge.

Station mark: Copper bolt in solid rock, over which is a rock cairn 5 feet in height.

[Latitude, 48° 24′ 01″.52. Longitude, 116° 38′ 55.″78.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Doust	232 53 14.44	53 12 26.21	4.5965347
Newton	236 01 09.17	56 31 23.44	4.7758946
Scotchman	299 03 30.80	119 28 52.14	4.6825857
Blacktail	343 00 37.10	163 06 22.39	4.5152727

DOUST, KOOTENAI COUNTY, IDAHO.

Location of station: About 7 miles southeast from Bonners Ferry. Best reached from Wright's ranch, in Paradise Valley. Follow trail leading to mineral claims of Doust & Wright to summit of Wright Mountain, thence along ridge over fallen timber to station; three hours' travel.

Station mark: Copper bolt in solid rock, above which is a rock cairn 5 feet in height.

[Latitude, 48° 36′ 50″.16. Longitude, 116° 13′ 18″.15.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Blacktail	21 59 49.24	201 46 25.83	4.7734417
Blue	53 12 26.21	232 53 14.44	4.5965347
Hell Roaring	179 57 47.07	359 57 46.29	4.5150730
Ewing	206 31 13.33	26 41 59.63	4.5929986
Cross	232 19 53.73	52 29 34.08	4.3000841
Newton	242 25 12.51	62 36 15.35	4.3089562
Scotchman	347 40 26.39	167 46 40.40	4.6847536

HELL ROARING, KOOTENAI COUNTY, IDAHO.

Location of station: On southern end of the eastern of two round peaks at the head of Hell Roaring Creek. From Round Prairie a trail runs south of Hell Roaring Creek to summit of mountain.

Station mark: Copper bolt in solid rock, above which is a rock cairn 4½ feet high.

[Latitude, 48° 54′ 30″.02. Longitude, 116° 13′ 19″.18.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Mooyie Trail monument	173 10 30.25	353 09 44.78	4.01339
Border	182 36 16.26	2 36 33.65	4.01348
Ewing	262 28 39.26	82 39 27.78	4.2471106
Cross	322 24 20.27	142 34 02.70	4.4137728
Doust	359 57 46.29	179 57 47.07	4.5150730

SCOTCHMAN (2), KOOTENAI COUNTY, IDAHO.

A secondary station near boundary post No. 72, at summit of Cabinet Mountain, occupied with transit.

[Latitude, 48° 12′ 50″.40. Longitude, 116° 03′ 14″.98.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Scotchman	37 07 25	217 06 08	3.54730
Divide	355 37 01	175 38 16	4.44183
Transit station 154	357 34 30	177 34 42	3.87099

BUCKHORN, KOOTENAI COUNTY, IDAHO.

A secondary station near boundary post No. 23, at summit of Yak Mountain, occupied with transit.

[Latitude, 48° 46′ 22″.57. Longitude, 116° 03′ 16″.03.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Doust	34 55 05.20	214 47 32.90	4.33338
Transit station 949	181 09 14.60	1 09 25.90	4.18013
Newton	325 15 17.30	145 18 48.30	4.00320
Ewing	196 47 42.90	16 51 04.97	4.25810
Cross	327 38 03.50	147 40 20.26	3.81428

BLACKTOP, KOOTENAI COUNTY, IDAHO.

A secondary station near boundary post No. 74. Reached from Clark Fork, Idaho, by trail to Homestake cabin; thence to divide between Blue and Mosquito creeks; then by four hours' travel (on foot) to station, following along slope of mountain.

Station mark: Cross cut on solid rock, under a rock monument 3 feet in height.

[Latitude, 48° 11′ 50″.72. Longitude, 116° 03′ 49″.28.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Scotchman	55 42 20	235 41 29	3.23516
Transit station 154	349 37 02	169 37 39	3.75359

NEWTON, FLATHEAD COUNTY, MONTANA.

Location of station: On second summit southeast of Newton Pass, on trail from Newton's ranch to Sylvanite.

Station mark: Iron bolt in solid rock, above which is a rock cairn 5 feet in height.

[Latitude, 48° 41′ 54″.51. Longitude, 115° 58′ 35″.26.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Scotchman	7 56 25.44	187 51 39.02	4.7576096
Blue	56 31 23.44	236.01 09.17	4.7758946
Doust	62 36 15.35	242 25 12.51	4.3089562
Cross	140 57 32.97	320 56 10.32	3.5525754
Ewing	178 55 40.21	358 55 22.48	4.4087123

EWING, FLATHEAD COUNTY, MONTANA.

Location of station: In extreme northwestern corner of State, about 35 miles northeast of Bonners Ferry, Idaho. It can be reached by trail to Buckhorn mines, thence along divide 4 miles to break-off, thence northeast down into the basin or meadows, thence ascending ridge in northwest direction, thence along ridge to summit.

Station mark: Copper bolt in loose rock, above which is cairn of rocks 4½ feet high.

[Latitude, 48° 55′ 43″.99. Longitude, 115° 58′ 58″.82.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Cross	4 25 15.00	184 24 09.92	4.3602056
Buckhorn	16 51 04.97	196 47 42.90	4.2581050
Doust	26 41 59.63	206 31 13.33	4.5929986
Transit station 949	65 56 28.90	245 53 26.30	3.7325500
Hell Roaring	82 39 27.78	262 28 39.26	4.2471106
Border	115 18 08.80	295 07 37.22	4.2747300
Newton	358 55 22.48	178 55 40.21	4.4087124

CROSS, FLATHEAD COUNTY, MONTANA.

Location of station: On first summit northwest of Newton Pass, on trail between Sylvanite and Newton's ranch.

Station mark: Copper bolt in loose rocks, above which is cairn of rocks 4½ feet high.

[Latitude, 48° 43′ 24″.24. Longitude, 116° 00′ 25″.26.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Doust	52 29 34.08	232 19 53.73	4.3000841
Hell Roaring	142 34 02.70	322 24 20.27	4.4137728
Buckhorn	147 40 20.26	327 38 03.50	3.8142800
Ewing	184 24 09.92	4 25 15.00	4.3602056
Newton	320 56 10.32	140 57 32.97	3.5525754

BORDER, IN CANADA.

Location of station: Just north of Kootenai County, Idaho. Reached from the Mooyie Trail by a trail to Grierson's ranch; thence by Indian trail to small lake lying to the east; thence around lake to ridge; thence up ridge to station.

Station mark: Copper bolt in solid rock, above which is a rock cairn 4½ feet high.

[Latitude, 49° 00′ 03″.60. Longitude, 116° 12′ 56″.12.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Hell Roaring	2 36 33.65	182 36 16.26	4.01348
Mooyie	87 49 12.16	267 48 09.25	3.22930
Ewing	295 07 37.22	115 18 08.80	4.27473

TRANSIT STATION 154.

A secondary station near boundary post No. 78; best reached by trail from Clark Fork, Idaho, by way of the Homestake cabin, to Blue Creek; two hours' travel to cabin, one and one-half hours from cabin to camp on Blue Creek. The ridge leading from Blue Creek to the station can be ascended on the south side in one and one-half hours.

Station mark: Copper bolt in rock, over which is a rock cairn 3 feet in height.

[Latitude, 48° 08′ 50″.14. Longitude, 116° 02′ 59″.84.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Blacktail	84 58 53	264 37 52	4.54599
Scotchman	152 05 45	332 04 17	3.71732
Scotchman (2)	177 34 42	357 34 30	3.87099
Divide	354 53 39	174 54 44	4.30621

TRANSIT STATION 949, NEAR IDAHO-MONTANA BOUNDARY LINE.

A secondary station on a large hill near boundary post No. 9, 6½ miles south of international boundary.

Station mark: None.

Reference mark: Signal tree, distant 138 feet, azimuth to which is 308° 55′.

[Latitude, 48° 54′ 32″.59. Longitude, 116° 03′ 01″.05.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Buckhorr	1 09 25.9	181 09 14.6	4.18013
Doust	21 04 23.9	200 56 39.8	4.54598
Ewing	245 53 26.3	65 56 28.9	3.73255

DIVIDE (2).

This triangulation station is not on the meridional portion of the line, but on the crest of the Bitterroot Mountains, farther south, and was located in connection with the survey of the Bitterroot Forest Reserve.

It is on the main summit of the Bitterroot Range, on the boundary line between Montana and Idaho, 20 miles (air line) west of Grantsdale. It can be reached from the Lost Horse Pass (camp being at Twin Lakes) by following the northwest face of the mountain northeast from the Twin Lakes to the crossing of Moose Creek, thence up the creek to the Meadows. The peak lies to the northwest, about 2,000 feet above the meadow.

Station mark: A rock cairn 5 feet in diameter and 8 feet in length.

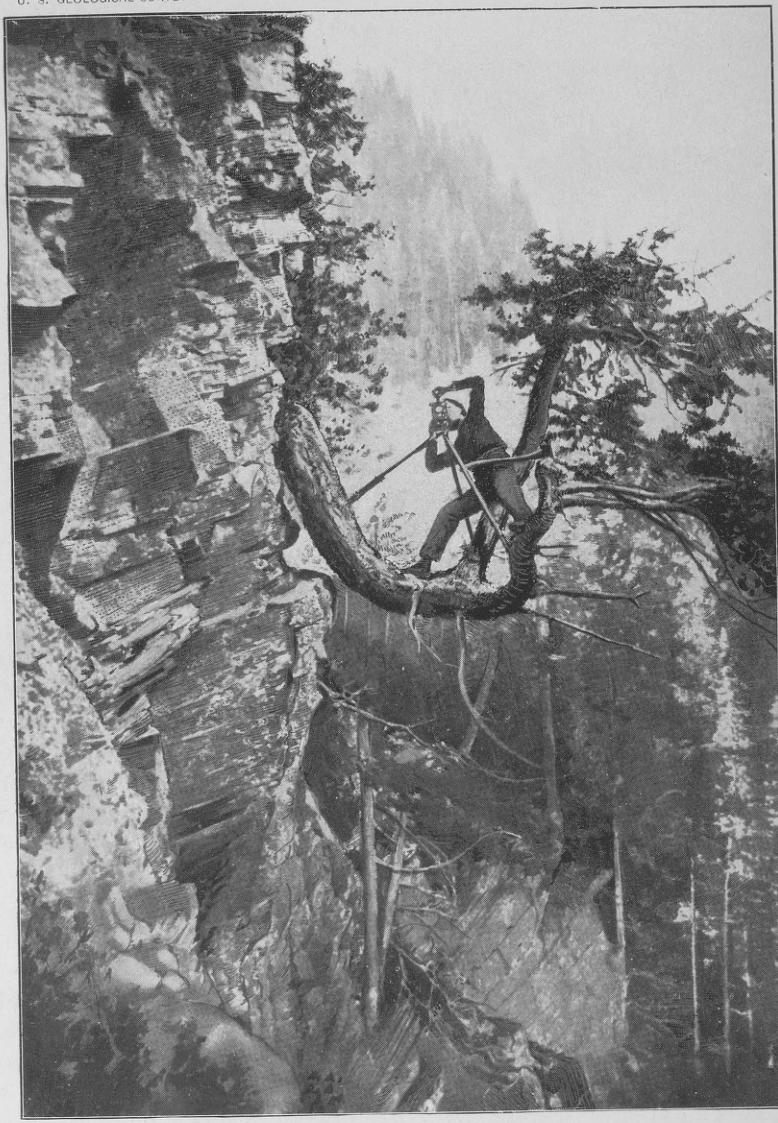
[Latitude, 46° 11′ 32″.1. Longitude, 114° 28′ 12″.2.]

To station—	Azimuth.	Back azimuth.	Log. distance.
	° ′ ″	° ′ ″	*Meters.*
Ward (2)	279 32 28	99 40 31	4.16360
El Capitan	344 06 39	164 09 53	4.32652

TRANSIT AND STADIA WORK.

The transit used was one manufactured by Young & Sons, of the type known as No. 10 mountain transit, the maker's number being 6838. The horizontal circle was $4\frac{3}{4}$ inches, and this circle, as well as the vertical circle, was graduated to read with verniers to 1′. The instrument was provided with a compass attachment, fixed stadia wires, and a tripod with extension legs. The extension legs were at times very necessary, as may be seen from Pl. VI. Two stadia rods, of seasoned white pine, three-fourths inch in thickness, 12 feet in length, and 4 inches across the faces, were made in Spokane. The lower portions of the rods were tapered to a point and shod with steel. The design of the rod was black on a white ground. (See fig. 1.) By a series of tests the stadia interval was found to be in the ratio of 1 foot on the rod to 100 feet horizontal distance, as nearly as could be determined, and the rods were graduated to even feet and tenths. The extreme divisions of the rods included 10 feet, and each tenth was divided into five parts, so that hundredths could be easily read by estimation. No numbers were placed on the rods. In practice the rods were held vertically, proper corrections being applied for reducing all sights to the horizontal.

There was no expectation of obtaining exact independent results for distances measured with the transit and stadia upon the basis of the stadia wires in the transit being set in the ratio of 1 to 100 and the



TRANSIT STATION ON RANDOM LINE.

rods being divided so as to read to hundredths. In point of fact, probably neither of these conditions existed, even when the instrument was fresh from the hands of the maker and when the rods were newly graduated at Spokane, and much less likely is it that they existed when the instrument was subject to rough field usage and the rods were used under entirely different and variable circumstances. It was believed, however, that they could be relied upon in determining intermediate distances between points the exact distances between which were known, and so long as the ratio between the wire interval and the graduated portions of the rods remained nearly constant the purpose intended to be subserved would be accomplished. Thus, when a line was run with the stadia between two points whose positions were rigidly fixed by triangulation and the resulting error was proportionately distributed, sufficiently accurate results were obtained, much more nearly accurate than could have been obtained by chaining, especially after certain corrections had been applied.

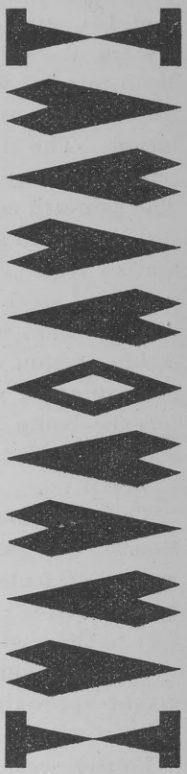


FIG. 1.—Design for stadia rod.

The method used in running the random line was as follows:

The line started from an astronomic azimuth, the initial point being on a high ridge and marked with a large signal. This signal was, when possible, used as a backsight, the instrument being transited in the direct and reversed position and the mean of the two points determined for the foresight being adopted. Of course in a timbered country it was generally not possible to see the backsights for any great distance, but whenever a ridge was crossed the trees were cut out (see Pls. IX and X) and a new backsight was established. In addition, frequent observations for astronomical azimuth were made, and thus additional checks were obtained. If any considerable discrepancy was discovered between the astronomical azimuth and the instrumental line, the latter was rerun in order to obtain a satisfactory check. Further, the line was connected with the triangulation and accurately adjusted thereto in azimuth as well as in distance. When the line was adjusted to the triangulation it was apparent that the transit man had introduced into his work a decided personal equation, which had the effect of constantly swinging his line in azimuth too far to the westward, as will appear hereafter. The stadia distances were read from both backsights and foresights, so that the length of each sight was obtained in duplicate, one distance depending on rod No. 1 and the other on rod No. 2, the mean being adopted. In the same

way vertical angles were checked by reading backsights and foresights; and thus levels were carried over the whole line. The height of the instrument above the ground station was determined at each point, and a corresponding height was sighted on the stadia rods. This height was obtained by having one of the legs of the tripod marked to tenths of a foot and by using the plumb bob as a measuring line.

The magnetic declination was read at each transit station.

The stadia line was divided into four sections:

First section. This section extended from the zero of the random line, namely, the summit of the Bitterroot Mountains, to transit station 154, and was controlled by connection with the triangulation system at both terminal points. At the summit of the Bitterroot Mountains it was connected by traverse with the triangulation station Divide, and transit station 154 was located directly by triangulation. The distance determined by stadia was 62,071 feet, and by triangulation 62,276 feet, the discrepancy being 205 feet, or 1 in 304. The azimuth correction in this section was found to be 0° 0′ 33″, corresponding to a swing of 10 feet to the east in the random line at station 154 in order to make it a true meridian line.

Second section. This section was included between stations 154 and 800. Station 800 was connected by a short traverse with the triangulation station Buckhorn. The distances determined by stadia and triangulation were, respectively, 228,014 and 228,734 feet, the difference being 720 feet, or 1 in 318. The azimuth swing at station 800 was 71 feet to the east, corresponding to an angular correction of 0° 01′ 04″.

Third section. This section was between stations 800 and 949. Station 949 was located directly by triangulation. The distance by stadia was 49,132 feet and by triangulation 49,190 feet, the difference being 58 feet, or 1 in 848. The swing in azimuth at station 949 amounted to 12.5 feet to the east, corresponding to an angular correction of 0° 0′ 52″.4.

The positions of transit stations 0, 154, 800, 949, and 1046 correspond approximately to those of monuments 92, 78, 23, 8, and 0, respectively.

Fourth section. This section closed on the international boundary, and it was unfortunate that a location by triangulation could not be obtained near its terminus, but the nature of the country rendered such a location impracticable, there being no elevated points near by and the timber being very tall and dense. It was therefore checked by careful steel-tape measurements, the tape being held horizontally under a constant tension of about 15 pounds, a plumb bob being used at each end. This section extended between station 949 and a point 45 feet north of station 1046. The distance by stadia was 33,103 feet and by steel-tape measurement 33,219 feet, the discrepancy being 116 feet, or 1 in 286.

It is proper to add that there are two small corrections which should

have been applied to the distance obtained and used on this section, one being that for reduction to sea level, amounting to −8 feet, and the other that for reduction on account of tape, which, after comparison with the United States Coast and Geodetic Survey standard, was found to be +12 feet. Thus, theoretically, the monument was placed 4 feet too far north, but the error, compared with that which might result from unavoidable station error, is so small that it may be considered as negligible.

It might be well to explain what is meant by "station error." It is the error which is more or less inherent in all astronomic determinations, being caused by the deviation of the plumb bob, on account of varying local attractions, from the true vertical. Its existence may be detected by direct measurements between two astronomic stations. Assuming an astronomic location to be made at A, a connection by triangulation with another station, B, and the position of B thus deduced from that of A, then if the astronomic position of B is determined, the discrepancy between the astronomic position and the position determined by triangulation from A represents the combined station error. Efforts have been made to deduce a law, based on the contour and density of adjacent land forms, which shall define the amount of attraction affecting the plumb bob which might be expected in any particular case, but nothing satisfactory has been accomplished, owing principally to the fact that it is impossible to give an accurate value to the various components which constitute the mass of any given section of the earth's crust.

The following table gives the results obtained directly from the stadia, and which were used in reducing the random line to the true line, both in distance and in azimuth. These figures do not, however, represent the degree of precision obtained by the stadia in measuring the distances, as they are unaffected by any corrections.

Table showing discrepancy between computed and measured distances, also discrepancy in azimuth.

Section.	Stations.	Computed distance.	Stadia distance.	Latitudinal discrepancy.	Discrepancy.	Longitudinal discrepancy, random line west of true line.	Discrepancy.	Mean angular error in azimuth.
		Feet.	*Feet.*	*Feet.*		*Feet.*		° ′ ″
1	0–154	62,276	62,071	205	1 in 304	10	1 in 6,228	0 0 33
2	154–800	228,734	228,014	720	1 in 318	71	1 in 3,222	0 1 04
3	800–949	49,190	49,132	58	1 in 848	12.5	1 in 3,927	0 0 53

The distances measured by the stadia should be corrected before any satisfactory comparison can be made with the computed distances for the purpose of testing the accuracy of the stadia work.

Two conditions will be considered. The first is based upon the

supposition that the rods were graduated arbitrarily into regular divisions, which were sufficiently small to admit of reading distances approximately to a foot, and that the stadia wires were set at some fixed interval. The fact that the rods were actually graduated so as to be read, as nearly as might be, to feet, tenths, and hundredths, and that the wire interval was approximate in the ratio of 1 to 100, does not enter at all into the theory of this condition. In fact the rod might be graduated in any systematic manner and the wires placed at any fixed interval without affecting the results after the proper corrections had been applied. An analogous case would be one in which certain distances were measured with a chain or tape the exact length of which was not known at the time the measurement was made but which was afterwards determined and the correction applied. The tape might prove to be 99 feet in length, but this would not affect the ultimate results after proper allowance had been made. The fourth section of the boundary line furnished a means by which the relation between the distances determined by the stadia and careful measurements with a steel tape, in other words, the stadia factor, might be ascertained.

Table of comparisons of stadia and steel-tape measurements from transit station 949 (post 8) to the international boundary (post 0), section 4.

Location.	Steel tape.	Stadia.	Difference.	Discrepancy.
	Feet.	*Feet.*	*Feet.*	
Station 949	0	0	0	
Post 7	4,618.6	4,601.5	17.1	1 in 270
Post 6	8,606	8,572	34	1 in 253
Post 5	13,760.5	13,698	62.5	1 in 220
Post 4	18,148.3	18,077	71.3	1 in 254
Post 3	23,596.2	23,512	84.2	1 in 280
Post 2	27,153	27,062.5	90.5	1 in 300
Post 1	31,106	31,000	106	1 in 293
Post 0	33,219	33,103	116	1 in 286

An inspection of the foregoing table will develop the fact that the ratio existing between the results from the steel-tape and the stadia measurements is fairly constant. The steel-tape measurements were carefully made with a 100-foot steel tape, under conditions approximating those under which the other portions of the line were measured independently by the stadia, except that the surface was probably not so broken and the change of elevation not so great, thus favoring the accuracy of the tape measurement. The steel tape was afterwards compared with the United States Coast and Geodetic Survey standard, and the values in the table are affected by a small correc-

tion necessary to reduce them to the standard. Thus the comparison may be considered as determining the stadia factor, or the amount by which each stadia distance should be corrected in order to reduce it to a true measurement.

It appears from the table that in a distance of 33,219 feet the stadia measurement was 33,103 feet, or a difference of 116 feet, which corresponds to 1 in 286; this correction to be added to the stadia results.

It might be argued that it would be preferable to obtain the stadia factor by direct comparison with the computed lengths of the lines in sections 1, 2, and 3; and so it would if the rods were to be used for other purposes, but for the present purpose, which is to make a comparison between the computed distances and the direct stadia measurements, the other method is adopted.

Table showing discrepancies between stadia distances corrected for stadia factor and computed distances.

Section.	Stations.	Stadia distance reduced to mean sea level.	Correction for stadia factor, 1 in 286.	Corrected stadia distance.	Computed distance.	Discrepancy; add to stadia distance.	Discrepancy.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	0–154	62,061	+217	62,278	62,276	— 2	1 in 31,139
2	154–800	227,967	+797	228,764	228,734	— 30	1 in 7,625
3	800–949	49,119	+172	49,291	49,190	—101	1 in 488

A combination of the figures in the foregoing table indicates that in a total distance of 340,200 feet, or about 65 miles, there was an apparent error of 133 feet, or 1 in about 2,565. It would not, of course, be proper to claim any such accuracy for the stadia work, and in fact the figures themselves do not justify such a claim, as the range between them is too great to admit of any general deduction from the three combined results. For the purposes of this discussion it would have been better if the line could have been divided into more numerous sections and if more than one comparison for the determination of the stadia factor could have been made.

A second condition is represented by the supposition that the rods were originally accurately subdivided so as to read to feet, tenths, and hundredths and that the stadia wires were at a fixed interval of 1 to 100. A correction inherent to this condition, from the theory of stadia measurement, is that of $f + c$, f corresponding to the distance from the plane of the cross wires to the objective, and c being the distance from the center of the instrument to the objective. In order to obtain a correct distance the measurement should, then, be from a point which is $f + c$, or, in the instrument used, 0.95 feet, ahead of the center of the transit. In other words, this amount should be added to the distance obtained at each transit station.

Table showing discrepancies between stadia distances affected by "$f+c$" correction and computed distances.

Section.	Stations.	Stadia distance reduced to mean sea level.	Correction for $f+c$.	Corrected distance.	Computed distance.	Discrepancy add to stadia distance.	Discrepancy.
		Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	
1	0– 154	62,061	+146	62,207	62,276	+ 69	1 in 903
2	154– 800	227,967	+614	228,581	228,734	+153	1 in 1,495
3	800– 949	49,119	+142	49,261	49,190	− 71	1 in 693
4	949–1,046	33,058	+ 92	33,150	33,174	+ 24	1 in 1,381

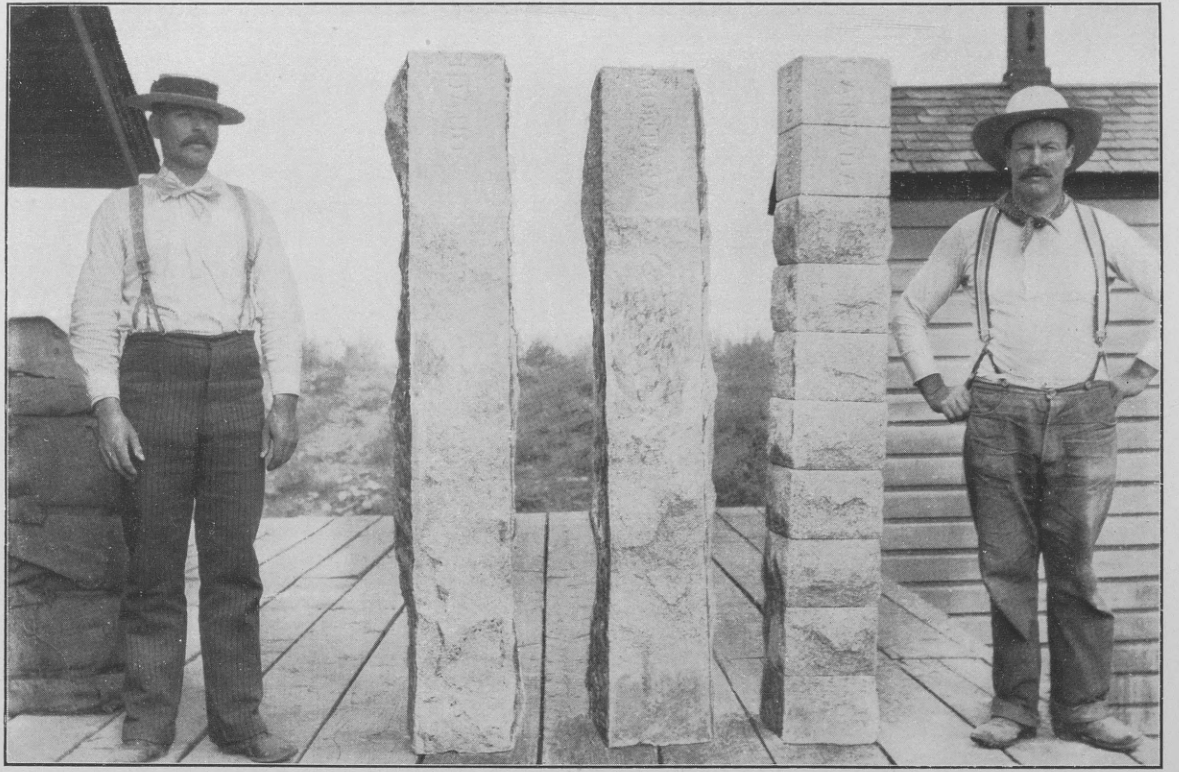
The mean discrepancy for the whole distance is 175 feet, or 1 in 2,133. This, it will be observed, approximates that obtained after application of the stadia-factor correction.

The results from the application of the $f+c$ correction serve to indicate that the rod was graduated approximately correctly, as intended, and the stadia wires were fixed so as to read distances on the rod approximately in the proportion of 1 to 100. As the stadia-factor correction was systematic, the results obtained for distances along the boundary line by a direct adjustment of the original stadia distances to fit the triangulation exactly correspond to those which would have been obtained if the stadia-factor correction had been first applied and the remaining discrepancy afterwards adjusted to the triangulation.

The only check obtained with reference to vertical distances or measurements of height is that furnished by the portion of the line between the Northern Pacific and Great Northern railroads. Along the former road is a line of precise levels run by the United States Geological Survey from a mean sea-level connection at Tacoma, Washington. The stadia line was connected with a bench mark of the precise levels, and this bench mark is the datum upon which the elevation of the stadia line is based. The profile of the Great Northern Railway adjusted to the United States Geological Survey precise levels furnished an elevation at Leonia to which the stadia line was joined. The resulting discrepancy was 73 feet, which is greater than might reasonably be expected, but it is possible that some of the error may be in the railroad profile.

The details relating to the profile of the boundary line between these two railroads are as follows: Sum of horizontal components, 201,188 feet; sum of vertical components, 42,700 feet; discrepancy in closure, 73 feet; discrepancy referred to horizontal components equals 1 in 2,756; discrepancy referred to vertical components equals 1 in 585.

Extensive and careful experiments with the stadia were made by the



GRANITE BOUNDARY-LINE MONUMENTS.

The monument on the right was cut in ten sections for transportation on pack animals.

Boundary Commission engaged in the survey and re-marking of the boundary between the United States and Mexico west of the Rio Grande; and as the conclusions reached so nearly correspond to those arrived at in connection with the Idaho-Montana line, the following quotations are made:

> The method by stadia is cheap and rapid; requires less cutting than that by chain; is carried on under the eye of an instrument man, presumably of a high order of intelligence; gives heights and angles, and enables objects to be located from the line which is being measured; is ordinarily more accurate than the chain, and can be successfully used where the chain can not be, experience on this survey having shown that the stadia lines over mountains, hills, and canyons were more accurate than those on level plains and wide valleys. * * *
>
> In view of this proof of the inevitable change in the value of the interval, the common practice of painting a rod to correspond with the stadia interval of a certain hour and day and then continuing the use of such rod unchecked and unchanged during the widely different seasons of this country oftentimes—in fact, for many years at a time—is seen to be inviting the large systematic error which almost without exception characterizes such work. If this evidence be taken to prove the fact that even so-called fixed stadia wires actually change their relative positions, or, what amounts to the same thing, appear to change on account of the influence of differential refraction at different seasons, then the present method of painting the rod to correspond with the determined interval is objectionable because of the cost of regraduating and repainting the rod to correspond to such change in interval. A method entirely free from this objection of cost, and one which the writer has found to stand every test during several years of field use, is that which uses rods divided into true units of feet, yards, or meters and employs an interval factor in the computation of distances. With this system a change in the interval simply means the loss of an hour's time in the preparation of a new table for reduced or true distances corresponding to any rod reading.

MONUMENTS.

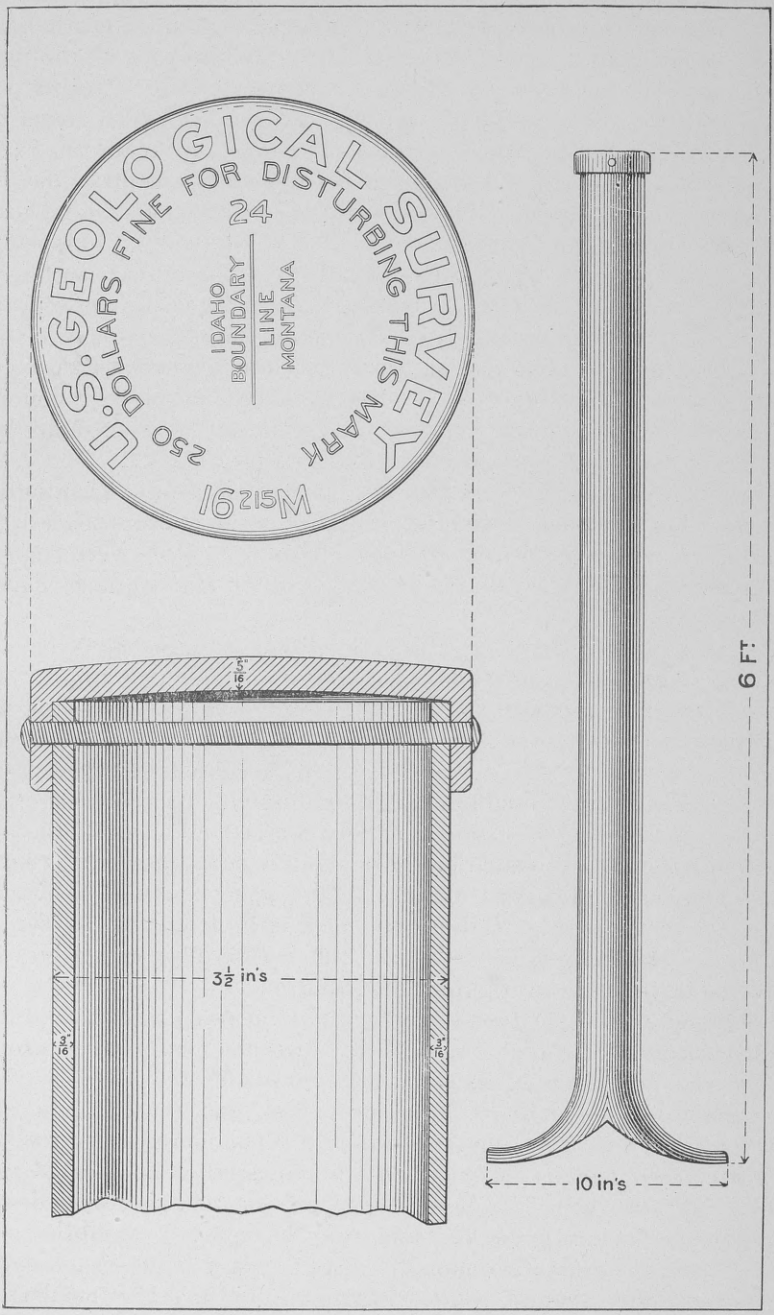
The monuments used along the meridional portion of the line are of two kinds—stone and iron. The stone monuments are of granite, 6 feet in length and 10 inches square, undressed except for spaces sufficient to permit cutting the words "Idaho" and "Montana," on opposite sides. These monuments are placed in the more prominent localities, and are monolithic in all cases where it was possible to transport them in one mass to the proper position; otherwise they were cut into ten sections, so that they could be carried on pack mules, and were bolted and cemented together when established in place. The monuments at the international boundary and at the summit of the Bitterroot Mountains, these being the terminal points of the meridional portion of the line, are of stone made from sections, as described, and monoliths are placed near the points at which the boundary line crosses the Northern Pacific and Great Northern railways. (See Pl. VII.) The iron monuments are hollow posts of wrought iron, 6 feet in length and about 4 inches in outer diameter, covered with a coat of asphaltum tar. At the bottom they are flared

to a width of 12 inches, to insure more secure planting. These posts are set to a depth of 3 feet below the surface of the ground, 3 feet remaining above ground, and a conical mound of earth being raised around them to a height of 2 feet. On the tops of the posts are riveted bronze caps, on which is cut appropriate lettering, and the number of the monument and the distance (in miles) from the international boundary are stamped in large figures. (See Pl. VIII.) In addition to the four stone monuments referred to, eighty-nine iron monuments were placed. The sites for the monuments were chosen with reference to the topographic features of the country, instead of being placed at even miles, as has usually been the custom on boundary lines, but there are few intervals greater than a mile between the monuments, the average interval being about three-fourths of a mile. They were placed generally on summits, or near streams, roads, or trails, and so as to be intervisible when possible. Between the monuments the line is thoroughly cut out, and adjacent trees are blazed, so that it can be readily recognized in any locality.

The stone monuments were quarried at Medical Lake, Washington, and cost $14.50 apiece delivered at the railroad station nearest the point at which they were established. The iron posts were made in St. Louis, and cost $2.08⅓ delivered to the United States quartermaster at St. Louis.

Previous to the work herein referred to no attempt had ever been made to locate and mark the Idaho-Montana boundary line, but the engineers of the Northern Pacific and Great Northern railways had estimated the points at which it crossed their tracks and established marks according to this estimation. The accepted crossing on the Northern Pacific was found to be about one-fourth of a mile west of the true line and that of the Great Northern about 1 mile east of the true line along the railway track, but only about a half mile east thereof in direct longitude. Kootenai County, Idaho, spent a considerable sum of money in grading a road up the mountain from Leonia toward Sylvanite, which, when the boundary line was located soon after, was found to be in Flathead County, Montana.

Each monument is witnessed by pits and mounds wherever practicable, the pits being dug across the line distant 4 feet north and south of the post, and the mounds being 4 feet east and west thereof. The dimensions of the pits are 3 by 2 by 1½ feet, and the mounds were constructed from the excavated material. The monuments are further witnessed, usually by four blazed bearing trees, one in each quadrant. The two trees in Idaho at post 48, for instance, were deeply engraved "Idaho P. 48 B. T.," and the two trees in Montana were marked in a corresponding manner. (See Pl. IX.) Under each monument was placed about a quart of charcoal. In the notes the distance and bearing to the witness trees were marked and the trees described.



DESIGN FOR IRON POST.

Complete copies of these notes can be found in the offices of the Geological Survey and the General Land Office in Washington and of the surveyors-general in Idaho and Montana.

A general description of the monuments is given below. The figures followed by the letter "M" indicate the distance in miles and hundredths of a mile from the initial monument.

Initial monument: Stone masonry monument, 6 feet long, 10 by 10 inches square, consisting of ten sections cemented and bolted together. An aluminum bench-mark tablet is set with cement in the top of the monument stamped "1899, Elev. 4500." The monument stands amid tall, dense timber on west slope of ridge, about a half mile east of creek.

1. Iron post, stamped "0.40 M.," on west slope of ridge, amid tall, dense timber.

2. Iron post, stamped "1.15 M.," on west slope of ridge, amid tall, dense timber.

3. Iron post, stamped "1.82 M.," on west slope of ridge, amid tall, dense timber.

4. Iron post, stamped "2.85 M.," on top of a ridge making out from the west slope of the main ridge, amid tall, dense timber.

5. Iron post, stamped "3.68 M.," between two branches, 30 feet apart, of a small creek flowing west, about a half mile east of the junction of said creek with a creek flowing north, amid dense timber.

6. Iron post, stamped "4.66 M.," 30 feet south of a creek flowing west and about one-fourth mile east of the junction of said creek with a creek flowing north, amid dense timber.

7. Iron post, stamped "5.415 M.," amid dense timber, 300 feet south of a small creek flowing west, and about one-fourth mile east of creek flowing northwest.

8. Iron post, stamped "6.295 M.," 2.5 miles north of the Buckhorn mine, on bare grassy ridge, 100 feet east of edge of green timber. A lone fir tree stands 200 feet east of the post.

9. Iron post, stamped "6.825 M.," 1¾ miles north of the Buckhorn mine, amid heavy fir timber, on west slope of high timbered ridge.

10. Iron post, stamped "7.53 M.," 1 mile north of the Buckhorn mine, on top of ridge, amid fir timber.

11. Iron post, stamped "8.21 M.," in north end of basin, at south edge of green timber, 100 feet east of foot of slope.

12. Iron post, stamped "8.61 M.," on top of bare ridge, a half mile east of the Buckhorn cabins.

13. Iron post, stamped "9.03 M." (post should have been stamped "9.00 M."), on top of bare rocky ridge, a half mile south of the Buckhorn mines, about 600 feet southeast from the highest point on the ridge.

14. Iron post, stamped "9.505 M." (post should have been stamped

"9.47 M."), on south edge, about halfway between the top of ridge and creek, on a small secondary ridge bearing S. 60° W., amid scattering fir timber, just north of an open space.

15. Iron post, stamped "10.16 M.," amid dense timber, on south bank of a creek flowing west, about 330 feet north of another creek flowing in same direction.

16. Iron post, stamped "11.005 M.," amid heavy timber, on top of a ridge on main west slope.

17. Iron post, stamped "11.49 M.," amid dense timber, on top of high ridge bearing west.

18. Iron post, stamped "12.12 M.," on top of a heavily timbered ridge south of creek in deep ravine, and a half mile east of creek flowing northwest.

19. Iron post, stamped "12.915 M.," 20 feet north of creek flowing northwest, about 1 mile north of Windy Pass trail.

20. Iron post, stamped "13.70 M.," on top of timbered ridge, 30 feet south of Windy Pass trail, three-fourths of a mile north of Skin Creek.

21. Iron post, stamped "14.40 M.," on top of north bank, 100 feet distant from Skin Creek, amid heavy timber.

22. Iron post, stamped "14.86 M.," 1¼ miles north of summit of Yak Mountain, a half mile south of Skin Creek, on top of heavily timbered ridge bearing northeast.

23. Iron post, stamped "15.62 M.," a half mile north of summit of Yak Mountain, on rocky ridge one-fifth of a mile northeast from Buckhorn triangulation station, amid scattering fir timber.

24. Iron post, stamped "16.215 M.," 10½ miles north of Leonia, on summit of Yak Mountain, 30 feet east of the highest point of the right-hand peak of three which are on the northwest end of the range as seen from the vicinity of Leonia. A signal tree stands 32 feet south and 2 feet east of the post. This post is visible from the whole surrounding country.

25. Iron post, stamped "16.81 M.," 9¾ miles north of Leonia, amid heavy timber, on slope of Yak Mountain, 0.6 mile south of the summit.

26. Iron post, stamped "17.50 M.," 9.1 miles north of Leonia, on top of a heavily timbered east-west ridge, on slope of Yak Mountain.

27. Iron post, stamped "18.05 M.," 8½ miles north of Leonia, one-fourth of a mile north of Curly Creek, on the south edge of a bench, at southern edge of thick growth of small pines.

28. Iron post, stamped "19.06 M.," 7½ miles north of Leonia, 1 mile north of Kinzie's ranch, at foot of mountain 2 miles west of Cross triangulation station, one-fifth of a mile north of Kingsley Creek, amid heavy timber.

29. Iron post, stamped "19.79 M.," 6¾ miles north of Leonia, amid heavy timber, 300 feet north of edge of meadow at Kinzie's ranch and 10 feet north of trail leading northwest from that ranch.

30. Iron post, stamped "20.40 M.," 6.1 miles north of Leonia, one-

POST 48, AT SUMMIT OF TIMBERED RIDGE.

fourth of a mile north of Newton's house, at north end of meadow, where a large spring comes out, 10 feet south of wagon road, 200 feet west of foot of hill.

31. Iron post, stamped "21.22 M.," 5.4 miles north of Leonia, a half mile south of Newton's house, at southeast corner of large meadow, at west edge of timber, and 75 feet east of Curly Creek.

32. Iron post, stamped "21.73 M.," 4.9 miles north of Leonia, about 1 mile north of Lang's ranch, 500 feet south of Curly Creek, and 10 feet north of wagon road.

33. Iron post, stamped "22.23 M.," 4.4 miles north of Leonia, 0.3 mile north of where the line crosses a valley just west of Lang's ranch, amid heavy timber on side hill, about midway between valley on the west and top of hill on the east.

34. Iron post, stamped "23.12 M.," 3.5 miles north of Leonia, 0.2 mile south of where the boundary line crosses Curly Creek, amid heavy timber on west slope, about 600 feet east of Curly Creek.

35. Iron post, stamped "24.10 M.," 2.5 miles north of Leonia, on top of a ridge bearing N. 30° E., where the line ascends from Curly Creek bottom, amid dense timber.

36. Iron post, stamped "24.965 M.," 1.7 miles north of Leonia, on high ground, 0.2 mile north of Lime Creek.

37. Iron post, stamped "25.79 M.," 0.9 mile north of Leonia, 10 feet south of wagon road, amid heavy timber.

38. Iron post, stamped "26.14 M.," a half mile north of Leonia, on top of east bank of Kootenai River, 180 feet above surface of water.

39. Stone monument, 6 feet by 10 inches by 10 inches, with an aluminum bench-mark tablet, stamped "26.64 M.," cemented in its top, located at Leonia, near foot of hill west of Great Northern Railway monument; bears S. 5° W., 584 feet distant from depot chimney. (See Pl. XI, *A*.)

40. Iron post, stamped "27.45 M.," 0.9 mile south of Leonia, at north edge of large timber and at south edge of brush, on steep east slope.

41. Iron post, stamped "28.215 M.," 1.6 miles south of Leonia, on flat amid heavy timber and dense underbrush, a half mile southwest of the Keeler cabins.

42. Iron post, stamped "29.115 M.," 2.5 miles south of Leonia, 0.3 mile south of a creek flowing east and 0.4 mile north of a creek flowing southeast into Star Creek, on top of a ridge bearing S. 45° E., amid thick small pines. (See Pl. X.)

43. Iron post, stamped "30.03 M.," 3.4 miles south of Leonia, on top of south bank of deep ravine, one-fifth of a mile west of where it joins a creek flowing southeast; amid heavy timber.

44. Iron post, stamped "31.03 M.," 4.4 miles south of Leonia, 1 mile north of Star Creek, amid heavy timber, on small ridge 200 feet north of small stream flowing east.

45. Iron post, stamped "32.17 M.," 5.5 miles south of Leonia, 200 feet south of Star Creek, a half mile below the mouth of a creek which empties into Star Creek from the southwest, about 600 feet above the mouth of a ravine which enters Star Creek from the southeast, and about 50 feet higher than the bed of creek; amid large timber.

46. Iron post, stamped "33.01 M.," 6.4 miles south of Leonia, 0.9 mile south of Star Creek, amid large scattering pine trees and dense small pines, on top of an east-west ridge about midway between Star Creek on the west and the top of high ridge on the east.

47. Iron post, stamped "33.74 M.," 7.2 miles south of Leonia, on steep slope draining west into Star Creek, 150 feet north of a small stream bearing N. 45° E., amid dead and scattering live timber.

48. Iron post, stamped "34.755 M.," 8.2 miles south of Leonia, on top of high timbered ridge, bearing SW.–NE., which forms the divide between Star and Callahan creeks. A line 20 feet in width was cut in the timber and can be seen from the summit of Yak Mountain and intermediate points to the north and from the summit of the Cabinet Mountains and intermediate points to the south. (See Pl. IX.)

49. Iron post, stamped "35.37 M.," 3.4 miles north of west fork of Callahan Creek, on top of a heavily timbered ridge bearing east–west, about a half mile east of the junction of said ridge with the main ridge, the point of junction being the highest point on the main ridge.

50. Iron post, stamped "36.31 M.," 2.5 miles north of the west fork of Callahan Creek, on top of a timbered ridge bearing NW.–SE., about 1,000 feet northwest of a trapper's cabin, in saddle on said ridge.

51. Iron post, stamped "36.86 M.," 2 miles north of the west fork of Callahan Creek, on west point of ridge, amid dead and scattering live trees about one-fourth of a mile west of top of high ridge bearing east.

52. Iron post, stamped "37.52 M.," 1.3 miles north of the west fork of Callahan Creek, on top of a bare ridge bearing southeast, about halfway between the top of the ridge on the west and a deep ravine on the east.

53. Iron post, stamped "38.57 M.," 0.25 mile north of the west fork of Callahan Creek, one-fourth of a mile west of a deep ravine from the north, on point of ridge bearing southeast, amid scattering trees and brush.

54. Iron post, stamped "39.59 M.," on top of high timbered ridge between the west and main forks of Callahan Creek.

55. Iron post, stamped "40.51 M.," in Callahan Creek bottom, 50 feet west of bank of creek and just east of the old Lightning Creek trail, amid large, dense timber.

56. Iron post, stamped "41.51 M.," 1 mile south of Callahan Creek on high, flat ridge bearing nearly east–west, amid tall timber.

POST 42, AND LINE CUT THROUGH TIMBER.

57. Iron post, stamped "42.35 M.," 1.8 miles south of Callahan Creek on top of timbered ridge bearing NE.–SW.

58. Iron post, stamped "43.50 M.," on top of high-timbered ridge which forms the divide between Callahan and Keeler creeks, near the head of the east fork of Callahan Creek.

59. Iron post, stamped "44.16 M.," on point of ridge between and about 300 feet west from the junction of two gulches which form the north branch of Keeler Creek, amid dense timber.

60. Iron post, stamped "44.72 M.," on top of heavily-timbered ridge bearing S. 60° E., between two forks of Keeler Creek.

61. Iron post, stamped "45.10 M.," in deep canyon, 50 feet south of the west fork of Keeler Creek, amid heavy timber.

62. Iron post, stamped "46.01 M.," on top of high east–west timbered ridge between two west forks of Keeler Creek.

63. Iron post, stamped "46.68 M.," amid heavy timber on top of bench 600 feet north and about 100 feet above the west fork of Keeler Creek, about a half mile west of the junction of the west fork with the main branch of that creek.

64. Iron post, stamped "47.78 M.," 150 feet north and 40 feet above Keeler Creek, which bears N. 30° E., nearly opposite the mouth of a canyon in the cliffs on east side of creek, at the east edge of timber.

65. Iron post, stamped "48.67 M.," 2.35 miles north of the east fork of Lightning Creek, on top of the east–west rocky ridge which forms the divide between Keeler and Lightning creeks, about 400 feet west of a saddle and 100 feet east of a hump on the ridge.

66. Iron post, stamped "49.54 M.," 1.5 miles north of the east fork of Lightning Creek, on top of a grassy east–west ridge, about 600 feet east of a peak where the ridge joins a north–south ridge, amid scattering fir trees.

67. Iron post, stamped "50.09 M.," 0.9 mile north of the east fork of Lightning Creek, at the top of slope, in top of rocks on southeast end of a ridge.

68. Iron post, stamped "50.99 M.," on bench 435 feet north of the east fork of Lightning Creek and about 200 feet higher than the creek, amid heavy timber nearly opposite the mouth of a ravine on south side of creek.

69. Iron post, stamped "51.85 M.," on top of high rocky ridge between two east forks of Lightning Creek, in top of rock ledge.

70. Iron post, stamped "52.725 M.," 10 feet south of the east fork of Lightning Creek, amid large timber.

71. Iron post, stamped "53.24 M.," a half mile south of the east fork of Lightning Creek, 1 mile north of summit of Cabinet Mountains, on top of ridge bearing N. 15° E., amid scattering pine and fir trees.

72. Iron post, stamped "54.22 M.," on summit of Cabinet Mountains, between the head waters of East Lightning and West Blue

creeks, about 1,000 feet northeast from a peak, at west edge of small fir trees and grass, where rocks begin in ascending the peak, about one-third mile west of a saddle on summit ridge. This point is visible from post 24 on the summit of the Yak Mountains and from all prominent intermediate points, also from post 92, on the summit of the Bitterroot Mountains and from intermediate points.

73. Iron post, stamped "54.905 M.," on top of narrow rocky ridge bearing S. 36° E., 0.7 mile south of the summit of the Cabinet Mountains, 0.4 mile south of basin at head of West Blue Creek, amid scattering fir and pine trees.

74. Iron post, stamped "55.58 M.," on top of rock ledge 1.4 miles south of the summit of the Cabinet Mountains, 0.7 mile north of West Blue Creek, on east slope of rocky ridge, 0.6 mile east of the triangulation station Blacktop, and 900 feet south of a small stream flowing east.

75. Iron post, stamped "56.285 M.," 2.1 miles south of the summit of the Cabinet Mountains, 30 feet east of West Blue Creek, 120 feet south of where line crosses creek under high cliffs on east side of creek, 8 feet south of a 36-inch hemlock stump and amid heavy timber.

76. Iron post, stamped "57.14 M.," 2.9 miles south of the summit of the Cabinet Mountains, on west side of West Blue Creek and 173 feet south of where line crosses it, opposite almost perpendicular cliffs on the east side of creek, about 0.25 mile above the mouth of a canyon from the northeast, amid large timber just west of an old trail.

77. Iron post, stamped "57.975 M.," 3.7 miles south of the summit of the Cabinet Mountains, on a small bench on steep rocky slope, one-fourth mile east of West Blue Creek.

78. Iron post, stamped "58.93 M.," 4.7 miles south of the summit of the Cabinet Mountains, on top of a narrow ridge, 200 feet above West Blue Creek and about opposite the south end of a long ridge on the west side of the creek, amid scattering pine trees.

79. Iron post, stamped "59.975 M.," 3 miles north of Clark Fork of Pend Oreille, on top of north bank of West Blue Creek at south side of large flat; in open ground.

80. Iron post, stamped "60.79 M.," 2.1 miles north of Clark Fork, on flat ground, amid heavy, dense timber, about 600 feet west of edge of bench, where the surface descends to West Blue Creek. An old trail crosses the line 150 feet south of the post.

81. Iron post, stamped "61.605 M.," 1.3 miles north of Clark Fork, on top of flat ridge, amid heavy timber, 30 feet southeast of a pond 100 feet in diameter.

82. Iron post, stamped "62.35 M.," 0.5 mile north of Clark Fork, on top of flat east-west ridge, amid heavy timber.

83. Stone monument 6 feet long, 10 inches by 10 inches square, with an aluminum bench-mark tablet stamped "63.03 M." cemented

A. GRANITE MONUMENT ON BOUNDARY LINE NEAR LEONIA, IDAHO.

B. SECTIONAL MONUMENT AT SUMMIT OF BITTERROOT MOUNTAINS.

in its top, located 7 feet north of the Northern Pacific Railway, 1 mile eastward from Cabinet, Idaho, 450 feet eastward from sign "1 mile to Cabinet," 150 feet eastward from a cut at sharp curve in railroad track.

84. Iron post, stamped "63.98 M.," 1 mile south of the Northern Pacific Railway, 0.2 mile northward from Baker's house, amid heavy timber on south bank of small stream flowing N. 75° W.

85. Iron post, stamped "64.95 M.," 1.9 miles south of the Northern Pacific Railway at the foot of mountain, 100 feet west of the mouth of a small stream in deep ravine; amid heavy timber.

86. Iron post, stamped "65.70 M.," 2.7 miles south of the Northern Pacific Railway, under west brow of a long, narrow ridge, about 300 feet south from where the ridge begins steep descent; amid dense timber.

87. Iron post, stamped "66.50 M.," 3.5 miles south of the Northern Pacific Railway, on top of high east-west ridge, about 300 feet east of its junction, with a north-south ridge; amid scattering large timber.

88. Iron post, stamped "67.46 M.," on top of high east-west timbered ridge, 1 mile north of the west fork of Elk Creek, about one-fourth mile east of where the ridge joins north and south ridge.

89. Iron post, stamped "68.475 M." (post should have been stamped "68.44 M."), in heavily timbered bottom, 60 feet north of the dry bed of the west fork of Elk Creek, about 1 mile west of the mouth of a creek from the southwest.

90. Iron post, stamped "69.08 M.," on top of narrow east-west ridge between the west fork of Elk Creek and a small stream from the southwest, amid timber.

91. Iron post, stamped "69.76 M.," on top of nearly bare ridge between two ravines bearing northeast.

92. Stone masonry monument, 6 feet long, 10 inches by 10 inches square, consisting of ten sections cemented and bolted together. An aluminum bench mark stamped "92–70.717 M., 4,850 feet" is cemented into the top of the monument. The monument stands on the top of a bare grassy ridge, amid scattering dead trees, at the junction of a ridge from the west with said ridge. The ridge at this point bears NW.–SE. and forms the summit of the Bitterroot Mountains. (See Pl. XI, *B*.)

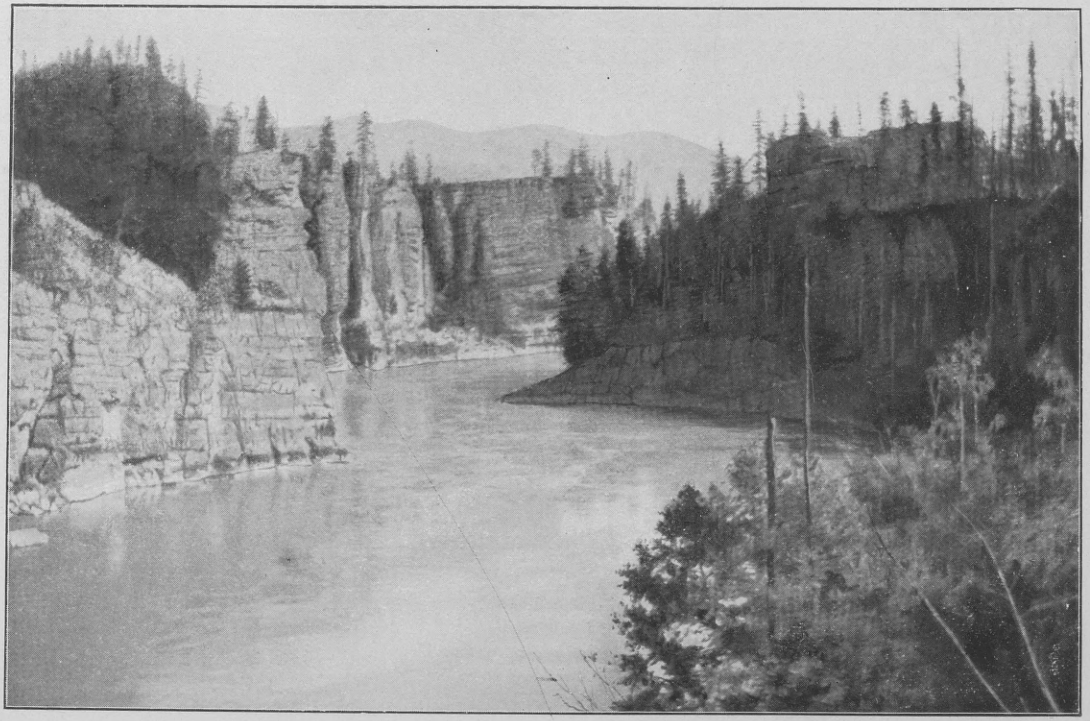
It will be recalled that it has been previously mentioned that an error was made in the field computation, the result of which was to locate the starting point of the random line 177 feet east of the true point. The transitman did not know of this error when he surveyed the random line, but as a result of a personal equation introduced into his work his line varied from a true line by a constant swing toward the west, so that when he reached the international boundary the point on the random line was 43 feet east of the true point. Thus, in

about 71 miles the transitman ran a line which at its terminal point was 134 feet "out" in azimuth. With this explanation the following table is self-explanatory:

Table showing number and kind of monuments, distances, elevations, magnetic declinations and time of magnetic observations along the boundary.

Number of monument.	Distance from international boundary.	Elevation at monument.	Distance west from random line.	Kind of monument.	Magnetic declination (east).	Time of magnetic observation.
	Miles.	*Feet.*	*Feet.*		° ′	
0	0.00	4,505	43	Stone		
1	0.40	4,691	49	Iron post.	23 10	9 a. m., Oct. 31, 1898.
2	1.15	5,008	59.5	do	23 02	1 p. m., Oct. 30, 1898.
3	1.82	5,186	65	do	23 15	8 a. m., Oct. 30, 1898.
4	2.85	5,496	74	do	23 18	1.30 p. m., Oct. 28, 1898.
5	3.68	5,223	79.8	do	23 06	3 p. m., Oct. 27, 1898.
6	4.66	5,167	82	do	23 00	3 p. m., Oct. 26, 1898.
7	5.415	5,477	82.5	do	23 08	8.30 a. m., Oct. 26, 1898.
8	6.295	6,124	83.5	do	23 08	11 a. m., Oct. 25, 1898.
9	6.825	5,954	84	do	23 02	3 p. m., Oct. 22, 1898.
10	7.53	6,069	85	do	23 02	8 a. m., Oct. 22, 1898.
11	8.21	5,712	86	do	23 03	1 p. m., Oct. 21, 1898.
12	8.61	6,116	87	do		
13	*a* 9.00	6,161	87	do	22 54	10 a. m., Oct. 21, 1898.
14	*b* 9.47	6,612	88	do	23 05	1 p. m., Oct. 20, 1898.
15	10.16	4,595	89	do	23 02	4 p. m., Oct. 19, 1898.
16	11.005	5,514	90	do	22 55	2 p. m., Oct. 18, 1898.
17	11.49	5,407	91	do	22 52	3.45 p. m., Oct. 17, 1898.
18	12.12	5,200	91.5	do	23 12	9 a. m., Oct. 17, 1898.
19	12.915	4,375	93	do	23 05	1 p. m., Oct. 15, 1898.
20	13.70	5,700	94	do	22 45	2 p. m., Oct. 10, 1898.
21	14.40	4,374	95	do	23 01	8 a. m., Oct. 10, 1898.
22	14.86	5,448	95	do	22 57	8.30 a. m., Oct. 8, 1898.
23	15.62	6,290	96	do	22 43	Noon, Oct. 7, 1898.
24	16.215	6,627	96	do		
25	16.81	5,406	97	do	23 03	5 p. m., Oct. 3, 1898.
26	17.50	4,966	98	do	23 25	1 p. m., Oct. 3, 1898.
27	18.05	3,817	98	do	22 30	5 p. m., Oct. 2, 1898.
28	19.06	2,864	99	do	23 00	10.30 a. m., Oct. 2, 1898.
29	19.79	2,523	100	do	23 08	1 p. m., Oct. 1, 1898.
30	20.40	2,504	100.5	do	23 05	8 a. m., Oct. 1, 1898.
31	21.22	2,490	101	do	23 02	9 a. m., Sept. 30, 1898.
32	21.73	2,520	102	do	22 59	4.30 p. m., Sept. 28, 1898.
33	22.23	2.694	102	do	22 50	11 a. m., Sept. 28, 1898.
34	23.12	2,541	103	do	22 56	1.30 p. m., Sept. 26, 1898.
35	24.10	2,418	104	do	23 00	8.30 a. m., Sept. 26, 1898.
36	24.965	2,425	105	do	22 50	1.30 p. m., Sept. 24, 1898.
37	25.79	2,199	106	do	22 08	4.30 p. m., Sept. 23, 1898.
38	26.14	1,978	107	do		
39	26.64	1,833	107	Stone	22 45	1 p. m., Sept. 23, 1898.
40	27.45	2,678	107	Iron post.	22 48	8 a. m., Sept. 23, 1898.
41	28.215	3,021	108	do	22 39	1.30 p. m., Sept. 20, 1898.
42	29.115	3,546	109	do	22 35	2.30 p. m., Sept. 19, 1898.

a Stamped 9.03. *b* Stamped 9.505.



CLARK FORK OF COLUMBIA RIVER JUST WEST OF BOUNDARY LINE.

Table showing number and kind of monuments, etc.—Continued.

Number of monument.	Distance from international boundary.	Elevation at monument.	Distance west from random line.	Kind of monument.	Magnetic declination (east).	Time of magnetic observation.
	Miles.	*Feet.*	*Feet.*		° ′	
43	30.03	3,533	110	Iron post	22 33	5 p. m., Sept. 18, 1898.
44	31.03	3,357	112	do	22 45	1 p. m., Sept. 16, 1898.
45	32.17	3,162	114	do		
46	33.01	4,410	115	do	22 27	1 p. m., Sept. 14, 1898.
47	33.74	4,392	116	do	22 40	4.30 p. m., Sept. 12, 1898.
48	34.755	6,127	118	do	22 38	8 a. m., Sept. 12, 1898.
49	35.37	5,993	119	do	22 25	11 a. m., Sept. 10, 1898.
50	36.31	5,535	120	do	22 15	2 p. m., Sept. 9, 1898.
51	36.86	5,572	121	do	22 43	9 a. m., Sept. 9, 1898.
52	37.52	4,740	182	do	21 26	12.30 p. m., Sept. 7, 1898.
53	38.57	3,498	109	do		
54	39.59	4,433	123	do	22 39	12.30 p. m., Sept. 5, 1898.
55	40.51	3,089	125	do	22 35	2.30 p. m., Sept. 4, 1898.
56	41.51	4,792	126	do	22 25	4 p. m., Sept. 3, 1898.
57	42.35	5,446	127	do	22 10	2.30 p. m., Sept. 2, 1898.
58	43.50	5,870	129	do	22 12	12.30 p. m., Aug. 29, 1898.
59	44.16	4,887	131	do	22 15	1.30 p. m., Aug. 27, 1898.
60	44.72	5,107	132	do	22 05	3 p. m., Aug. 26, 1898.
61	45.10	3,992	133	do	22 23	9 a. m., Aug. 26, 1898.
62	46.01	5,176	134	do	25 20	2.30 p. m., Aug. 24, 1898.
63	46.68	3,867	135.5	do	21 45	5 p. m., Aug. 23, 1898.
64	47.78	4,052	137	do	22 02	4.30 p. m., Aug. 20, 1898.
65	48.67	5,666	139	do	22 20	2 p. m., Aug. 19, 1898.
66	49.54	5,781	139	do	22 35	9 a. m., Aug. 19, 1898.
67	50.09	5,822	139	do	22 28	2.30 p. m., Aug. 13, 1898.
68	50.99	3,623	141	do	22 20	2.30 p. m., Aug. 12, 1898.
69	51.85	5,902	141	do	23 10	10 a. m., Aug. 11, 1898.
70	52.725	4,084	142	do	22 35	10 a. m., Aug. 9, 1898.
71	53.24	5,366	142	do	22 30	3 p. m., Aug. 8, 1898.
72	54.22	6,780	163	do	23 14	8 a. m., Aug. 8, 1898.
73	54.905	6,197	163	do	22 28	7.30 a. m., Aug. 6, 1898.
74	55.58	5,349	164	do	21 50	1 p. m., Aug. 5, 1898.
75	56.285	4,139	165	do	23 10	8.45 a. m., Aug. 3, 1898.
76	57.14	3,774	166	do	22 30	11 a. m., July 30, 1898.
77	57.975	3,856	166	do	22 52	6.30 p. m., July 28, 1898.
78	58.93	4,206	167	do	23 05	10 a. m., July 28, 1898.
79	59.975	2,655	168	do	22 33	1.30 p. m., July 27, 1898.
80	60.79	2,662	169	do	22 15	Noon, July 26, 1898.
81	61.605	2,667	169	do	22 27	4 p. m., July 24, 1898.
82	62.35	2,487	170	do	22 32	1.30 p. m., July 22, 1898.
83	63.03	2,225	170	Stone	22 22	3 p. m., July 21, 1898.
84	63.98	2,416	171	Iron post	22 22	3.45 p. m., July 20, 1898.
85	64.94	2,501	172	do	22 26	9.30 a. m., July 19, 1898.
86	65.70	3,990	173	do	22 20	12.30 p. m., July 18, 1898.
87	66.50	4,953	173	do	22 04	10.30 a. m., July 16, 1898.
88	67.46	4,793	174	do	22 20	4 p. m., July 14, 1898.
89	*a* 68.44	2,667	175	do	22 20	11 a. m., July 13, 1898.
90	69.08	4,341	176	do	22 20	11 a. m., July 12, 1898.
91	69.76	3,555	176	do		
92	70.717	4,848	177	Stone	22 15	10.30 a. m., July 9, 1898.

a Stamped 68.475.

THE INTERNATIONAL BOUNDARY WEST OF THE SUMMIT OF THE ROCKY MOUNTAINS, AND THE MOOYIE TRAIL MONUMENT.

On August 11, 1856, a law was passed by Congress authorizing the appointment of a commission to unite with a similar commission to be appointed by Great Britain for the purpose of carrying into effect the first article of the treaty of June 15, 1846, that is to determine and mark the boundary line between the United States and British possessions westward from the summit of the Rocky Mountains. In February, 1857, Mr. Archibald Campbell was appointed commissioner for the United States, and Lieut. John G. Parke, United States Army, was appointed chief astronomer and surveyor. Three commissioners were appointed by Great Britain. Captains Prevost and Richards, of the Royal Navy, were first and second commissioners, respectively, their duties being limited to the determination of the water boundary referred to as "the channel which separates the Continent from Vancouver's Island." In the summer of 1858, Col. J. S. Hawkins, Royal Engineers, appointed by the British Government commissioner to determine the boundary line along the forty-ninth parallel, arrived in the United States prepared for field operations. At a meeting of the joint commission the following agreement relating to the plan of work was entered into:

> After discussing plans for determining and marking the line as far eastward as the Cascade Mountains, it was concluded to be inexpedient at the present time, in consequence of the great expense, consumption of time, and the impracticable nature of the country, to mark the whole boundary by cutting a track through the dense forest.
>
> It was therefore agreed to ascertain points on the line by the determination of astronomical points at convenient intervals on or near the boundary and to mark such astronomical stations, or points fixed on the parallel forming the boundary, by cutting a track of not less than 20 feet in width on each side for the distance of half a mile or more, according to circumstances. Further, that the boundary be determined and similarly marked where it crosses streams of any size, permanent trails, or any striking natural feature of the country.
>
> In the vicinity of settlements on or near the line it is deemed advisable to cut the track for a greater distance and to mark it in a manner to be determined hereafter.

Under this plan it seems that the work was prosecuted through the field seasons of 1858, 1859, and 1860, but owing to the war between the States, which followed soon after, all operations were suspended, and no detailed report was ever published.

The following is an extract from a short report by Mr. Archibald Campbell, United States commissioner, published in House Executive Document No. 86, Fortieth Congress, third session:

> The work of running and marking the land boundary was carried on through a country previously almost unknown. The forty-ninth parallel extends over rugged and precipitous mountains that attain great elevation, and in the Cascade

Range, on and near the boundary, perpetual snow covers many of the peaks, whose northern gorges are filled up with immense glaciers. The timber on the western slope of the Cascade Mountains is dense, being a heavy growth of pine and fir that in many places stands over a fallen forest not yet decayed. This is the character of the country as far eastward as the valley of the Similkameen River, one of the tributaries of the Columbia. Here the timber becomes more open and surveying operations less difficult.

After passing the Okinokane River, which is the lowest line of the great valley between the Cascade and the Rocky Mountains, the country again becomes rough and the timber more dense, but less so than the western slope of the Cascade Mountains.

It being impossible to follow the forty-ninth parallel continuously, the line of survey was carried over the nearest practicable route for a pack trail, connecting each astronomical station, making a total length of line of survey of about 800 miles. Astronomical stations were established by parties of the joint commission at almost every accessible point from which the boundary line is ascertained, and marked by a vista across all valleys and trails, where rough stone monuments were erected over posts buried in the ground to indicate the exact line.

The reconnoissance work extends over an area of about 30,000 square miles. Within this space the barometrical heights of over 800 points have been obtained.

A magnetic survey, extending over a range of 30° 20′ in latitude and 4° in longitude, with the necessary observations of the magnetic elements of the astronomical stations, was also made.

The entire length of the land boundary line is over 9° in longitude, or about 410 miles, and the length of the route traveled in surveying it is double that distance. Trails had to be opened for three-fourths of the distance traveled, involving great labor in cutting, grading, and bridging to make the route practicable for pack-mule transportation. The water courses were numerous and rapid, rendering the fords frequent and dangerous, and a slight rise of many of the streams would have made them impassable but for the timely precaution of building bridges at small streams and ferryboats at the river crossings. Many of the trails opened are now traveled routes to the mines then and since discovered, which are rapidly developing that section of the country, where almost every valley of any extent affords facilities for agricultural pursuits.

In collating the results of the survey reports upon the geology, botany, and natural history of the country reconnoitered were prepared and complete maps, on a large scale, made of the entire boundary and the adjacent country. A general map has also been made, showing the extent of the country traversed. And to facilitate the survey of the public lands photographic duplicates of the detailed sheets, showing each monument on the boundary line, with its geographical position, were furnished to the General Land Office. Photographic duplicates of the detailed sheets of the water boundary have also been made and furnished the Department of State in illustration of the question of the boundary channel.

Copies of the maps referred to in Mr. Campbell's reports are in existence. The boundary-line maps are in 14 sheets, with the title, Detailed Maps of the Northwest Boundary, from Point Roberts to the Rocky Mountains, between the United States and the British Possessions, under the treaty of June 15, 1846, showing monuments, cuts, and other marks. The scale of the maps is 1:60,000, and the topography is shown in hachures. The general map referred to is in contours and apparently on the same scale as the detailed maps.

From an inspection of the detailed map it appears that there are

two portions of the boundary line which seem to be adequately marked, one of them being from Point Roberts, on Juan de Fuca Strait, eastward for a distance of about 41 miles, and the other being from Similkameen River, across the northern boundary of what was formerly the Colville Indian Reservation, to the Columbia River, a distance of about 91 miles; the eastern part of this latter portion, however, is not so well marked as the western part.

The portions which are inadequately marked—in fact, not marked at all—comprise intervals as follows:

Portions of international boundary west of the summit of the Rocky Mountains and the Mooyie Trail monument which are not marked.

	Miles (approximate).
West slope of Cascade Mountains	16
Across summit of Cascade Mountains to Pasayten River	54
Pasayten River to one hundred and twentieth meridian	24
One hundred and twentieth meridian to Similkameen River	15
Columbia River to Clark Fork	10
Clark Fork to Kootenai Mountain	11
Kootenai Mountain to Kootenai River	28
Kootenai River to Mooyie Trail	15
Mooyie River to Yaak River	25
Yaak River to summit west of Kootenai River	17
Summit west of Kootenai River to Kootenai River	5
Kootenai River to summit	5
Summit to Wigwam River	14
Wigwam River to Flathead River	14
Flathead River to Kishemeen Creek	4
Kishemeen Creek to summit of Rocky Mountains	13

There is no question as to the desirability of properly marking the boundary line, although it is true that the unmarked portions are in a rough, mountainous, and unsettled section, and the expense and labor connected with making the necessary resurveys and placing monuments would be large.

When the boundary line between Idaho and Montana was run northward to the international boundary, it was not possible to locate its terminal point as satisfactorily as might have been desired, because of the fact that there was no monument on the international boundary within a reasonable distance with which a connection could be made. The same is true of the boundary line between Washington and Idaho, and also of a guide meridian run by the Geological Survey northward from the thirteenth standard parallel in Idaho. The Washington Forest Reserve, the Priest River Forest Reserve, and the Flathead Forest Reserve abut against this boundary, and in making the topographic survey of these reserves, as well as in projecting the public-land lines northward, it is very important that there should be well-defined monuments to which these surveys can be connected. There are, of course, many other apparent reasons

SUMMIT OF BITTERROOT MOUNTAINS, SHOWING PACK TRAIN LOADED WITH SECTIONS OF GRANITE MONUMENT.

why the international boundary should be permanently and conspicuously marked, but special reference is made to those mentioned, for they have a bearing on the work of the Geological Survey.

As the instructions relating to the Idaho-Montana boundary line provided for a connection by triangulation or other methods with a monument on the international boundary, inquiry was made at the State Department for information on the subject and permission was granted to examine the records of the Northwest Boundary Survey. A visit was made to the manuscript room of the Department, and several lists of geographical positions were found. As these positions have not been published heretofore, two lists are given below. The second list gives geographical positions, and is signed by officers of the British and American commissions.

Extracts from State Department records of United States Northwest Boundary Survey.

[In lead-colored chest in manuscript room.]

Camp Columbia	[1]117° 37′ 33″.9 on brink of hill, west bank of river.
	[1]117° 37′ 05″.2 near east bank of river.
Camp Kootenay West	116° 35′ 44″.9 on side of mountain, west side of valley.
	116° 31′ 05″.9 on brow of first hill, right bank of river.
Camp Mooyie	116° 12′ 22″.3 on side of mountain, west side of valley.
	116° 11′ 54″.5 on plateau above creek. Position approximate.
	116° 11′ 25″.6 on left bank of creek close to water.
	116° 11′ 24″ on high bluff left bank. Position approximate.
Camp Kootenay East	115° 16′ 01″.4 on east bank of ravine beyond which the mountains rise.
	115° 11′ 11″.2 on right bank of Kootenay River.
	115° 10′ 11″.6 on second plateau, left bank of river.
	115° 03′ 28″.7 at foot of mountain, left bank small creek.
	(N. B.—This station was moved from its position as placed by the United States surveyors by the British surveyors. Description is of the new position.)

	Lat. N.			Long. W. Gr.		
	°	′	″	°	′	″
Camp Columbia	48	59	50.4	117	37	41.8
Fort Shepherd Station	49	00	00.0	117	37	19.4
Junction of Salmon River with Clarks Fork	49	01	32.4	117	23	24.5
Pend O'Reille Station	49	00	03.5	117	21	52.9
Kootenay Mountain Station	49	00	12.8	117	10	48.4
Triangulation pole	48	58	48.0	117	00	33.1
Sinyakuateen depot	48	09	23.8	116	43	42.9
Camp Kootenay West	48	59	55.1	116	31	16.2
Junction of trails near Acklewcache	48	54	21.4	116	22	02.1
Mooyie Trail monument	49	00	01.3	116	14	59.2
Camp Mooyie	49	01	26.0	116	12	40.5
Yaht Station	48	59	55.4	115	38	51.0

[1] Monuments changed by English commission after verification.

From the foregoing list it appeared that the Mooyie Trail monument was the point on the international boundary nearest the Idaho-Montana boundary line, and Mr. Perkins was instructed to make a search for it. The monument is about 32 miles from Bonners Ferry, Idaho, and is easily reached by the new Wild Horse trail. It is on the west side of and near the trail between Round Meadows hay ranch, or Walters Prairie, and Mooyie River, and about 5 miles from the former. It is about a half mile beyond a section of the trail which for a distance of about one-fourth mile is filled with loose rock. As the monument is approached the trail passes through a heavy growth of timber and underbrush. The monument consists of a large pile of partly angular rocks, now knocked down by fallen trees. Originally, the trees in the immediate vicinity of the monument were cut down.

It will be observed that the latitude for the Mooyie Trail monument given in the list signed by the officers of the United States and British commissions is 49° 00′ 01″.3, or 1″.3 (about 132 feet) north of the parallel constituting the international boundary, and it was supposed that the point marked by the monument was in that latitude, and therefore not exactly on the international boundary. During the field season of 1898 the triangulation was extended so as to locate this monument, and its position deduced from the Spokane base is as follows: Latitude, 49° 00′ 01″.51; longitude, 116° 14′ 19″.48.

The check in latitude, 21 feet, was considered very satisfactory, and even the discrepancy in longitude, about 2,647 feet, was not more than might be expected, considering the lack of telegraphic facilities at the time of the Northwest Boundary survey. The point determined as the true one for the intersection of the international boundary and the Idaho-Montana boundary line was located with reference to the Mooyie Trail monument, so that there need be no large discrepancy, except that due to station error, when the international boundary is ultimately traced and marked, it being assumed that the work already done by the Northwest Boundary survey will be accepted and utilized.

The distance from the point on the Idaho-Montana boundary line at the crest of the Bitterroot Mountains to the international boundary, used in placing the initial monument, was computed as follows, the constants being taken from United States Coast and Geodetic Survey Report, 1884, Appendix No. 6:

	Latitude.		
	°	′	″
Transit station, crest of Bitterroot Mountains	47	58	35.56
International parallel	49	0	0.00
Difference	1	01	24.44

	1° =69.097 miles=364,832 feet.	
	1′ =1,853.16 meters.	
log.	1″ =30.886 meters,	1.489762
log.	24″.44	1.388101
log.	754.85 meters =	2.877863
	1,853.16	
log.	2,608.01 meters,	3.416309
log.	meters to feet,	0.515984
log.	8,554 feet =	3.932293
	364,832	
	373,386 feet.	
Correction[1] =	+21	
	373,407 feet, total distance.	

FINANCIAL STATEMENT.

A financial statement is presented below showing how the amount appropriated for the survey of the boundary line was expended. As already mentioned, however, this amount does not represent the entire cost of the work, for the greater portion of the animals and outfit were transferred from other localities, where they had been used by parties of the Geological Survey working under other appropriations. Further, it was possible to use a portion of the triangulation done in connection with the forest surveys, and the expenses of the party while engaged in sketching topography were charged in part against the appropriation for topographic surveys. No portion of the salary of the geographer in charge of the work was paid from the appropriation for the boundary line, nor were any office salaries charged against it. But for this material assistance, which did not in any way detract from other work, the cost of the boundary survey would probably have been increased more than twofold. On the other hand, a large portion of what was accomplished in connection with the boundary line can be utilized in other directions. The appropriation of $7,650 was originally made for expenditure during the fiscal year ending June 30, 1898. The unexpended balance on that date was, however, made available by act of Congress for the year ending June 30, 1899, and again, in a similar manner, the unexpended balance at the latter date was reappropriated for the fiscal year ending June 30, 1900. The appropriation became practically exhausted in October, 1899.

[1] By triangulation connection with Mooyie Trail monument, the position of this monument is 0.″21 farther north than as given by the international boundary survey, hence to reduce all positions to the international-boundary survey system, latitudes of United States Geological Survey triangulation are decreased 0″.21, or its equivalent, 21 feet, the distance from initial point on Bitterroot Mountains to forty-ninth parallel being increased 21 feet.

Financial statement relating to appropriation for survey of boundary line between Idaho and Montana.

Date.	To whom paid.	For what paid.	Amount.
1897.			
June 30	E. T. Perkins, jr., topographer	Services, June 8–30	$101.10
July 3	do	Traveling expenses	60.75
10	G. M. Metzler	Shoeing, etc	23.00
10	Isaac I. Lewis	Tollage supplies, etc	13.57
10	Lindsay & Merriam	Subsistence supplies	61.04
10	F. O. Berg	Tentage	19.90
10	Holly, Mason, Marks & Co	Hardware	52.50
10	Spokane Dry Goods Co	Saddles, blankets, and pack covers	43.48
12	Mark E. Davis	Saddlery, etc	32.50
12	S. H. Rush	Saddlery, etc	33.75
15	E. T. Perkins, jr	Field expenses	160.56
24	E. C. Murphy	One mule	30.00
29	E. T. Perkins, jr	Field expenses	73.05
31	Pay roll of employees	Services, July, 1897	241.60
Aug. 7	C. P. Willis	One horse	15.00
17	Exchange National Bank	Horses and mules	143.10
17	E. T. Perkins, jr	Field expenses	116.12
19	United States Express Co	Freight	46.57
25	Chicago and Northwestern Railway Co.	Transportation	12.50
31	Pay roll of employees	Services, August, 1897	241.60
Sept. 4	E. T. Perkins, jr	Field expenses	120.65
4	S. H. Rush	Harness	34.50
8	Richard Smith	Wagon	75.00
11	Oregon Short Line R. R	Transportation	50.69
28	E. T. Perkins, jr	Field expenses	50.65
30	Pay roll of employees	Services, September, 1897	213.80
Oct. 11	H. Baumgarten	Stamps	.30
14	John O'Connell	Transportation	20.00
18	Young & Sons	Transit	255.00
30	E. T. Perkins, jr	Field expenses	192.56
31	Pay roll of employees	Services, October, 1897	236.60
Nov. 11	Northern Pacific Railway Co	Transportation	4.25
15	E. T. Perkins, jr	Field expenses	196.44
Dec. 4	Pay roll of employees	Services, November, 1897	193.97
8	Schoellhorn-Albrecht Machine Co	Iron monuments	208.33
20	E. T. Perkins, jr	Field expenses	108.45
1898.			
Jan. 13	Northwestern Storage and Transportation Co.	Storage	4.50
17	do	do	2.85
Feb. 10	P. Morrison	Pasturage	36.50
12	H. L. Schermerhorn	Storage	4.50
Mar. 12	do	do	4.50
15	Western Union Telegraph Co	Telegrams	3.84
15	do	do	.80
31	P. Morrison	Pasturage	15.00
Apr. 8	H. Louis Schermerhorn	Storage	4.50
14	P. Morrison	Pasturage	15.00
May 10	Northwestern Storage and Transportation Co.	Storage	4.50
10	P. Morrison	Pasturage	15.00

Financial statement relating to appropriation for survey of boundary line between Idaho and Montana—Continued.

Date.	To whom paid.	For what paid.	Amount.
1898.			
June 8	P. Morrison	Pasturage	$15.00
11	H. Louis Schermerhorn	Storage	4.50
July 13	Lindsay & Hall	Subsistence supplies	59.45
Aug. 3	Pay roll of employees	Services, July, 1898	414.67
11	Arend & Kenward	Subsistence supplies	36.00
11	Holly, Mason, Marks & Co	Hardware	10.90
11	P. Morrison	Pasturage	15.00
17	D. L. Reaburn	Field expenses	59.08
Sept. 13	do	do	35.30
13	R. U. Goode	do	23.15
13	Gordon Daugherty	Subsistence supplies	49.41
13	Pay roll of employees	Services, August, 1898	473.06
13	Giles & Peat	Stone monuments	58.00
13	D. L. Reaburn	Field expenses	43.77
21	Oregon Railroad and Navigation Co	Transportation	16.65
21	F. B. Collow	Subsistence supplies	77.54
21	Northern Pacific Railway Co	Transportation	32.10
Oct. 11	Pay roll of employees	Services, September, 1898	465.00
14	W. E. R. Brewster	Subsistence supplies	79.80
Nov. 7	Pay roll of employees	Services, October, 1898	425.00
7	D. L. Reaburn	Field expenses	189.68
16	do	do	161.12
26	do	do	137.17
26	Northern Pacific Railway Co	Transportation	9.90
Oct. 19	Southern Pacific Co	do	38.00
19	do	do	17.05
Dec. 12	S. W. Johnson	Pasturage	13.65
1899.			
Jan. 17	Great Northern Railway Co	Transportation	15.15
Feb. 16	United States Express Co	Expressage	10.65
Mar. 20	Western Union Telegraph Co	Telegrams	.90
20	do	do	.48
June 30	Pay roll of employees	Services, June, 1899	316.67
July 17	D. L. Reaburn	Field expenses	213.75
31	Pay roll of employees	Services, July, 1899	352.10
Aug. 8	E. J. Brooks & Co	Steel dies and letters	2.12
Sept. 12	D. L. Reaburn	Field expenses	152.96
16	do	do	21.40
	Total		7,649.50
	Amount appropriated		7,650.00
	Balance		.50

BOUNDARY BETWEEN IDAHO AND MONTANA

FROM THE INTERNATIONAL BOUNDARY TO THE CREST OF THE BITTERROOT MOUNTAINS, BEING THE 39TH MERIDIAN WEST FROM WASHINGTON, AS SURVEYED AND MARKED BY THE

UNITED STATES GEOLOGICAL SURVEY

UNDER ACT OF CONGRESS APPROVED JUNE 4TH 1897

Scale
1 0 1 2 3 MILES

Contour interval 100 feet
Datum is mean sea level
▪ Iron monuments
▣ Stone monuments
— — — Boundary line

116°05' CANADA BOUNDARY 116°00'
49°00' UNITED STATES LINE 49°00'

1 0.40 M
2 1.15 M
3 1.82 M
4 2.85 M
5 3.68 M
6 4.66 M
7 5.415 M
8 6.295 M
9 6.825 M
10 7.53 M
11 8.21 M
12 8.61 M
Buckhorn Cabin
13 8.900 M
14 9.47 M
15 10.16 M
16 11.005 M
17 11.49 M
18 12.12 M
19 12.915 M
20 13.70 M
Windy Pass Trail
Skin Cr.
21 14.40 M
22 14.86 M
YAAK MTS.
Buckhorn
23 15.62 M
24 16.215 M
25 16.81 M
26 17.50 M
27 18.05 M
Curly Cr.
28 19.06 M
Kingsley Cr.
29 19.79 M
Kinzie's Stable
30 20.40 M
Isaac Newton
Joseph Varco
31 21.22 M
32 21.73 M
Lake
33 22.23 M
Jacob Lang
Curly Cr.
34 23.12 M
Curly Cr.
35 24.10 M
36 24.965 M
Lime Cr.
GREAT NORTHERN R.R.
37 25.79 M
38 26.14 M
Boulder Cr.
NORTHERN PACIFIC R.R.
Leonia
39 26.64 M
Road to Sylvanite
40 27.45 M
Cabin
41 28.215 M
42 29.115 M
43 30.03 M
44 31.03 M
Star Cr.
45 32.17 M
46 33.01 M
47 33.74 M
48 34.755 M
49 35.37 M
A

55' 55'
50' 50'
45' 45'
40' 40'
35' 35'
48°30' 30'

A
50 36.31 M
Trapper's Cabin
51 36.86 M
52 37.52 M
53 38.57 M
West Fork Callahan Cr.
54 39.59 M
Callahan Cr.
25' 25'
55 40.31 M
Lightning Cr. Trail
56 41.51 M
57 42.35 M
58 43.50 M
59 44.16 M
60 44.72 M
61 45.10 M
West Fork Keeler Cr.
20' 20'
62 46.01 M
Keeler Cr.
63 46.69 M
64 47.18 M
65 48.67 M
66 49.54 M
67 50.09 M
Fork of Lightning Cr.
68 50.99 M
15' 15'
69 51.85 M
Fork of Lightning Cr.
70 52.725 M
71 53.24 M
72 54.22 M
Scotchman (2)
CABINET MTS.
73 54.905 M
Blacktop
74 55.58 M
Scotchman
75 56.285 M
76 57.14 M
10' 10'
77 57.975 M
78 58.93 M
79 59.975 M
80 60.79 M
West Blue Cr.
81 61.605 M
82 62.35 M
Old N.P.R.R. Trail
83 63.03 M
NORTHERN PACIFIC R.R.
CLARK FORK
05' 05'
Wagon Road
84 63.98 M
Baker's House
85 64.95 M
86 65.70 M
87 66.50 M
88 67.46 M
89 68.44 M
West Fork Elk Cr.
Elk Creek
48°00' 48°00'
116°05' 116°00'
90 69.08 M
BITTERROOT MTS.
91 69.76 M
92 70.717 M
Divide

Cross ▲

JULIUS BIEN & CO. LITH. N.Y.

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ADVERTISEMENT.

[Bulletin 170.]

The statute approved March 3, 1879, establishing the United States Geological Survey, contains the following provisions:

"The publications of the Geological Survey shall consist of the annual report of operations, geological and economic maps illustrating the resources and classification of the lands, and reports upon general and economic geology and paleontology. The annual report of operations of the Geological Survey shall accompany the annual report of the Secretary of the Interior. All special memoirs and reports of said Survey shall be issued in uniform quarto series if deemed necessary by the Director, but otherwise in ordinary octavos. Three thousand copies of each shall be published for scientific exchanges and for sale at the price of publication; and all literary and cartographic materials received in exchange shall be the property of the United States and form a part of the library of the organization; and the money resulting from the sale of such publications shall be covered into the Treasury of the United States."

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When, in 1882, the Geological Survey was directed by law to make a geologic map of the United States, there was in existence no suitable topographic map to serve as a base for the geologic map. The preparation of such a topographic map was therefore immediately begun. About one-fifth of the area of the country, excluding Alaska, has now been thus mapped. The map is published in atlas sheets, each sheet representing a small quadrangular district, as explained under the next heading. The separate sheets are sold at 5 cents each when fewer than 100 copies are purchased, but when they are ordered in lots of 100 or more copies, whether of the same sheet or of different sheets, the price is 2 cents each. The mapped areas are widely scattered, nearly every State being represented. About 900 sheets have been engraved and printed; they are tabulated by States in the Survey's "List of Publications," a pamphlet which may be had on application.

The map sheets represent a great variety of topographic features, and with the aid of descriptive text they can be used to illustrate topographic forms. This has led to the projection of an educational series of topographic folios, for use wherever geography is taught in high schools, academies, and colleges. Of this series the first two folios have been issued, viz:

1. Physiographic types, by Henry Gannett, 1898, folio, consisting of the following sheets and 4 pages of descriptive text: Fargo (N. Dak.-Minn.), a region in youth; Charleston (W. Va.), a region in maturity; Caldwell (Kans.), a region in old age; Palmyra (Va.), a rejuvenated region; Mount Shasta (Cal.), a young volcanic mountain; Eagle (Wis.), moraines; Sun Prairie (Wis.), drumlins; Donaldsonville (La.), river flood plains; Boothbay (Me.), a fiord coast; Atlantic City (N. J.), a barrier-beach coast.

2. Physiographic types, by Henry Gannett, 1900, folio, consisting of the following sheets and 11 pages of descriptive text: Norfolk (Va.-N. C.), a coast swamp; Marshall (Mo.), a graded river; Lexington (Nebr.), an overloaded stream; Harrisburg (Pa.), Appalachian ridges; Poteau Mountain (Ark.-Ind. T.), Ozark ridges; Marshall (Ark.), Ozark Plateau; West Denver (Colo.), hogbacks; Mount Taylor (N. Mex.), volcanic peaks, plateaus, and necks; Cucamonga (Cal.), alluvial cones; Crater Lake special (Oreg.), a crater.

GEOLOGIC ATLAS OF THE UNITED STATES.

The Geologic Atlas of the United States is the final form of publication of the topographic and geologic maps. The atlas is issued in parts, or folios, progressively as the surveys are extended, and is designed ultimately to cover the entire country.

Under the plan adopted the entire area of the country is divided into small rectangular districts (designated *quadrangles*), bounded by certain meridians and parallels. The unit of survey is also the unit of publication, and the maps and descriptions of each rectangular district are issued as a folio of the Geologic Atlas.

Each folio contains topographic, geologic, economic, and structural maps, together with textual descriptions and explanations, and is designated by the name of a principal town or of a prominent natural feature within the district.

Two forms of issue have been adopted, a "library edition" and a "field edition." In both the sheets are bound between heavy paper covers, but the library copies are permanently bound, while the sheets and covers of the field copies are only temporarily wired together.

Under the law a copy of each folio is sent to certain public libraries and educational institutions. The remainder are sold at 25 cents each, except such as contain an unusual amount of matter, which are priced accordingly. Prepayment is obligatory. The folios ready for distribution are here listed.

No.	Name of sheet.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
1	Livingston	Montana	110°–111°	45°–46°	3,354	25
2	Ringgold	Georgia, Tennessee	85°–85° 30′	34° 30′–35°	980	25
3	Placerville	California	120° 30′–121°	38° 30′–39°	932	25
4	Kingston *a*	Tennessee	84° 30′–85°	35° 30′–36°	969	25
5	Sacramento	California	121°–121° 30′	38° 30′–39°	932	25
6	Chattanooga	Tennessee	85°–85° 30′	35°–35° 30′	975	25
7	Pikes Peak *a*	Colorado	105°–105° 30′	38° 30′–39°	932	25
8	Sewanee	Tennessee	85° 30′–86°	35°–35° 30′	975	25
9	Anthracite-Crested Butte.	Colorado	106° 45′–107° 15′	38° 45′–39°	465	50
10	Harpers Ferry	Virginia, West Va., Maryland.	77° 30′–78°	39°–39° 30′	925	25
11	Jackson	California	120° 30′–121°	38°–38° 30′	938	25
12	Estillville	Virginia, Kentucky, Tennessee	82° 30′–83°	36° 30′–37°	957	25
13	Fredericksburg	Maryland, Virginia	77°–77° 30′	38°–38° 30′	938	25
14	Staunton	Virginia, West Va.	79°–79° 30′	38°–38° 30′	938	25
15	Lassen Peak	California	121°–122°	40°–41°	3,634	25
16	Knoxville	Tennessee, N. Carolina	83° 30′–84°	35° 30′–36°	925	25
17	Marysville	California	121° 30′–122°	39°–39° 30′	925	25
18	Smartsville	California	121°–121° 30′	39°–39° 30′	925	25
19	Stevenson	Alabama, Georgia, Tennessee	85° 30′–86°	34° 30′–35°	980	25
20	Cleveland	Tennessee	84° 30′–85°	35°–35° 30′	975	25
21	Pikeville	Tennessee	85°–85° 30′	35° 30′–36°	969	25
22	McMinnville	Tennessee	85° 30′–86°	35° 30′–36°	969	25
23	Nomini	Maryland, Virginia	76° 30′–77°	38°–38° 30′	938	25
24	Three Forks	Montana	111°–112°	45°–46°	3,354	50
25	Loudon	Tennessee	84°–84° 30′	35° 30′–36°	969	25
26	Pocahontas	Virginia, West Va.	81°–81° 30′	37°–37° 30′	951	25
27	Morristown	Tennessee	83°–83° 30′		963	25
28	Piedmont	Maryland, West Va.	79°–79° 30′	39°–39° 30′	925	25
29	Nevada City:					
	Nevada City	California.	121° 00′ 25″–121° 03′ 45″	39° 13′ 50″–39° 17′ 16″	11.65	50
	Grass Valley		121° 01′ 35″–121° 05′ 04″	39° 10′ 22″–39° 13′ 50″	12.09	
	Banner Hill		120° 57′ 05″–121° 00′ 25″	39° 13′ 50″–39° 17′ 16″	11.65	
30	Yellowstone National Park:					
	Gallatin, Canyon, Shoshone, Lake	Wyoming.	110°–111°	44°–45°	3,412	75
31	Pyramid Peak	California.	120°–120° 30′	38° 30′–39°	932	25
32	Franklin	Virginia, West Va.	79°–79° 30′	38° 30′–39°	932	25
33	Briceville	Tennessee	84°–84° 30′	36′–36° 30′	963	25
34	Buckhannon	West Va.	80°–80° 30′	38° 30′–39°	932	25
35	Gadsden	Alabama.	86°–86° 30′	34°–34° 30′	986	25
36	Pueblo	Colorado.	104° 30′–105°	38°–38° 30′	938	50
37	Downieville	California.	120° 30′–121°	39° 30′–40°	919	25
38	Butte Special	Montana.	112° 29′ 30″–112° 36′ 42″	45° 59′ 28″–46° 02′ 54″	22.80	50
39	Truckee	California.	120°–120° 30′	39°–39° 30′	925	25
40	Wartburg	Tennessee	84° 30′–85°	36°–36° 30′	963	25
41	Sonora	California.	120°–120° 30′	37° 30′–38°	944	25
42	Nueces	Texas	100°–100° 30′	29° 30′–30°	1,035	25
43	Bidwell Bar	California.	121°–121° 30′	39° 30′–40°	918	25
44	Tazewell	Virginia, West Va.	81° 30′–82°	37°–37° 30′	950	25
45	Boise	Idaho	116°–116° 30′	43° 30′–44°	864	25
46	Richmond	Kentucky	84°–84° 30′	37° 30′–38°	944	25
47	London	Kentucky	84°–84° 30′	37°–37° 30′	950	25
48	Tenmile District Special.	Colorado.	106° 8′–106° 16′	39° 22′ 30″–39° 30′ 30″	55	25
49	Roseburg	Oregon	123°–123° 30′	43°–43° 30′	871	25
50	Holyoke	Mass, Conn	72° 30′–73°	42°–42° 30′	885	50
51	Big Trees	California	120°–120° 30′	38°–38° 30′	938	25
52	Absaroka:					
	Crandall, Ishawooa	Wyoming.	109° 30′–110°	44°–44° 30′	1,706	25
53	Standingstone	Tennessee	85°–85° 30′	36°–36° 30′	963	25

a Out of stock.

No.	Name of sheet.	State.	Limiting meridians.	Limiting parallels.	Area, in square miles.	Price, in cents.
54	Tacoma.....	Washington.	122°–122° 30′	47°–47° 30′	812	25
55	Fort Benton	Montana..	110°–111°	47°–48°	3,273	25
56	Little Belt Mts ...	Montana..	110°–111°	46°–47°	3,295	25
57	Telluride	Colorado..	107° 45′–108°	37° 45′–38°	236	25
58	Elmoro	Colorado..	104°–104° 30′	37°–37° 30′	950	25

STATISTICAL PAPERS.

Mineral Resources of the United States, 1882, by Albert Williams, jr. 1883. 8°. xvii, 813 pp. Price 50 cents.

Mineral Resources of the United States, 1883 and 1884, by Albert Williams, jr. 1885. 8°. xiv, 1016 pp. Price 60 cents.

Mineral Resources of the United States, 1885. Division of Mining Statistics and Technology. 1886. 8°. vii, 576 pp. Price 40 cents.

Mineral Resources of the United States, 1886, by David T. Day. 1887. 8°. viii, 813 pp. Price 50 cents.

Mineral Resources of the United States, 1887, by David T. Day. 1888. 8°. vii, 832 pp. Price 50 cents.

Mineral Resources of the United States, 1888, by David T. Day. 1890. 8°. vii, 652 pp. Price 50 cents.

Mineral Resources of the United States, 1889 and 1890, by David T. Day. 1892. 8°. viii, 671 pp. Price 50 cents.

Mineral Resources of the United States, 1891, by David T. Day. 1893. 8°. vii, 630 pp. Price 50 cents.

Mineral Resources of the United States, 1892, by David T. Day. 1893. 8°. vii, 850 pp. Price 50 cents.

Mineral Resources of the United States, 1893, by David T. Day. 1894. 8°. viii, 810 pp. Price 50 cents.

On March 2, 1895, the following provision was included in an act of Congress:

"*Provided*, That hereafter the report of the mineral resources of the United States shall be issued, as a part of the report of the Director of the Geological Survey."

In compliance with this legislation the following reports have been published:

Mineral Resources of the United States, 1894, David T. Day, Chief of Division. 1895. 8°. xv, 646 pp., 23 pl.; xix, 735 pp., 6 pl. Being Parts III and IV of the Sixteenth Annual Report.

Mineral Resources of the United States, 1895, David T. Day, Chief of Division. 1896. 8°. xxiii, 542 pp., 8 pl. and maps; iii, 543–1058 pp., 9–13 pl. Being Part III (in 2 vols.) of the Seventeenth Annual Report.

Mineral Resources of the United States, 1896, David T. Day, Chief of Division. 1897. 8°. xii, 642 pp., 1 pl.; 643–1400 pp. Being Part V (in 2 vols.) of the Eighteenth Annual Report.

Mineral Resources of the United States, 1897, David T. Day, Chief of Division. 1898. 8°. viii, 651 pp., 11 pl.; viii, 706 pp. Being Part VI (in 2 vols.) of the Nineteenth Annual Report.

Mineral Resources of the United States, 1898, David T. Day, Chief of Division. 1899. 8°. viii, 616 pp.; ix, 804 pp., 1 pl. Being Part VI (in 2 vols.) of the Twentieth Annual Report.

The money received from the sale of the Survey publications is deposited in the Treasury, and the Secretary of the Treasury declines to receive bank checks, drafts, or postage stamps; all remittances, therefore, must be by MONEY ORDER, made payable to the Director of the United States Geological Survey, or in CURRENCY—the exact amount. Correspondence relating to the publications of the Survey should be addressed to—

THE DIRECTOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C.

WASHINGTON, D. C., *June, 1900.*

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Washington | government printing office | 1900
Second title: United States geological survey | Charles D. Walcott, director | — | Survey | of the | boundary line between Idaho and Montana | from | the international boundary to the crest | of the Bitterroot Mountains | by | Richard Urquhart Goode |
Washington | government printing office | 1900
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Author.

Goode (Richard Urquhart).
United States geological survey | Charles D. Walcott, director | — | Survey | of the | boundary line between Idaho and Montana | from | the international boundary to the crest | of the Bitterroot Mountains | by | Richard Urquhart Goode | [Vignette] |
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Subject.

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[UNITED STATES. *Department of the interior.* (*U. S. geological survey.*) Bulletin 170.]